2182D-11680 (AUMS/SEG)

28 April 2008

OXYGEN SYSTEM COMPATILITY TEST – CF188 NACES CONFIGURATION

Ref: A. Telecons Ellis/Michas/Gordge 28 Aug 2007

B. Tasking Project Definition, 2182D-11680(DTAES 7-4-2), 12 Oct 07

C. Telecon Michas/Rioux, Jan 08

BACKGROUND

1. The CF188 fleet will be retrofitted with the SJU-17 ejection seat also known as the Navy Aircrew Common Ejection Seat (NACES). A change in oxygen system plumbing is associated with the retrofit. There is a requirement to confirm oxygen system compatibility specifically between the SABRE regulator and plumbing for the CF188 NACES configuration (Ref A), and DRDC Toronto was tasked accordingly (Ref B).

AIM and OBJECTIVES

- 2. The aim of this task was to confirm compatibility of the oxygen SABRE regulator and plumbing configuration in CF188 aircraft equipped with the NACES SJU-17 ejection seat. The objective was to conduct tests throughout the oxygen system operating range.
- 3. Although the inner configuration of all parts is not visible, the apparent physical change to the oxygen system for NACES is a slight increase in the most relevant dimension, namely inside diameter. The expected impact would be to improve overall system performance. Direct comparative testing between the configurations was considered unnecessary (Ref C).

EQUIPMENT UNDER TEST

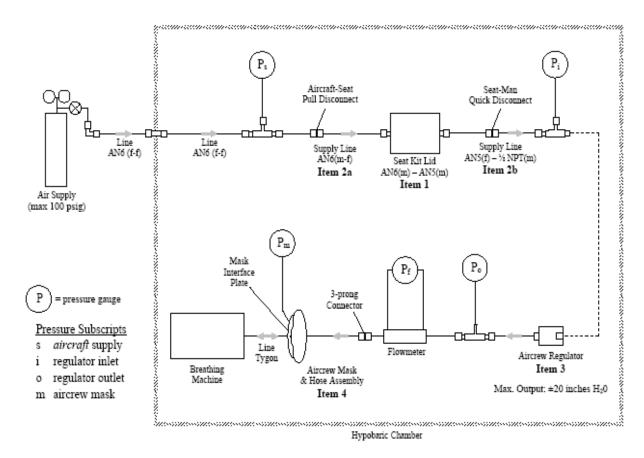
4. The test item comprises CF188 oxygen system components in the NACES configuration from the pull-disconnect interface between the aircraft supply and seat kit to through to the aircrew oxygen mask including seat kit and Sabre oxygen regulator.

METHOD

- 5. Testing was conducted in the hypobaric chamber at DRDC Toronto. Test set-up was as illustrated in Figure 1. A total of 84 tests were conducted with variable settings as summarized in Table 1 comprising a common baseline test¹ and five test groups for examining effects of varied parameters:
 - a. inlet pressure $(P_{in}) 18$ tests;
 - b. mode(M) 7 tests;
 - c. altitude (H) 28 tests;
 - d. multiple extremes 16 tests; and
 - e. breathing profile 14 tests.

The single baseline test is applicable in comparisons within each *parameter effect* group.

Figure 1. NACES oxygen system compatibility test setup



Gas medium used in the test system was air with inlet (simulated aircraft supply) pressure set at approximately 40, 70 (normal) and 100 psig. The oxygen regulator was tested in both operating modes: dilution (D) and 100% oxygen (100%). Test altitude (H) ranged from ground level (where mass flow and likelihood of unusual characteristic is highest) to 45,000 feet, with three selected intermediate settings. Various dynamic sinusoidal flow-time profiles, from very low to very high rates, were generated using a programmable breathing machine interfaced with the oxygen mask. Ranges of breathing rate, minute volume (or average flow, f_{avg}) and peak inspiration flow (f_{pk}) were, respectively, 8-22 breaths per minute (bpm), 5-40 lpm minute and 30-250 lpm. Expiration was a sinusoidal profile over a fixed time interval, with range of peak flow 40-310 lpm (determined by tidal volume).

- 6. Test interval was 90 s with the following continuous (50 Hz) data measures:
 - a. inspiration flow at mask hose (Fleish pneumotach); and
 - b. pressure (Validyne transducer):
 - 1) aircraft supply before pull-disconnect;
 - 2) regulator inlet;
 - 3) regulator outlet, or mask hose; and
 - 4) mask cavity.
- 7. Data were examined for trends and any sign of undesirable characteristics such as unstable, excessive or insufficient pressure, the latter reflecting gas supply "starvation".

RESULTS and DISCUSSION

- 8. Results are presented graphically in Annex A on a separate sheet for each test, sheets in turn comprising separate panels of breathing machine (flow generator) position, demand ("inspiration") flow and the four measured pressures.
- 9. The data shows that pressures are consistently and highly responsive to flow demand regardless of breathing rate (number of breaths per minute) and minute volume (average demand per minute). Flow demand is successfully achieved in all conditions. Pressure responds to the breathing cycle and becomes stable immediately in that successive cycles are essentially identical. Higher frequency oscillations typical in 100% mode (e.g., Test 20) are attributed to regulator and mask characteristics and considered of negligible consequence. Mask pressure appears to be determined more by mask resistance characteristics than the oxygen supply system, with magnitudes during the breathing cycle (minimum, maximum and swing) consistently greater than those at the regulator outlet. There is no evidence of insufficient supply pressure (regulator "starvation") even at low setting, 100% mode and extreme flow demand (e.g., Tests 17, 66). Multiple parameter changes seem consistent with combined effects of individual parameter changes. Overall, no anomalies or areas of concern are evident regarding the NACES breathing system configuration.
- 10. A few expected trends and known oxygen system properties were seen as follows:
 - a. Safety pressure in *dilution* mode at 30K (e.g., Test 41), in 100% mode at low altitude (e.g., Test 20). The same level of positive pressure at high altitude in both operating modes (e.g., Test 60 vs 68).
 - b. Slight decrease in mask pressure (minimum, maximum & swing) as altitude increases through 15K (e.g., Test 1 vs 27 vs 34), attributed to less mass flow at altitude for a given volume demand.

CONCLUSION

11. Results of the extensive tests her e of the NACES oxygen system configuration, in each regulator mode and over the expected operating range for inlet pressure, altitude and breathing profile, individually and in combination, demonstrate acceptable performance and confirm compatibility among system components.

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Reviewed:

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30 Apr 08

Date

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Table 1. CF188 NACES Oxygen System Compatibility Tests

M regulator operating mode

D dilution

P_{in} air supply pressure

H altitude

R breathing rate

F_{avg} average flow, or minute ventilation

F_{pk-in} peak flow in breathing cycle

GL ground level

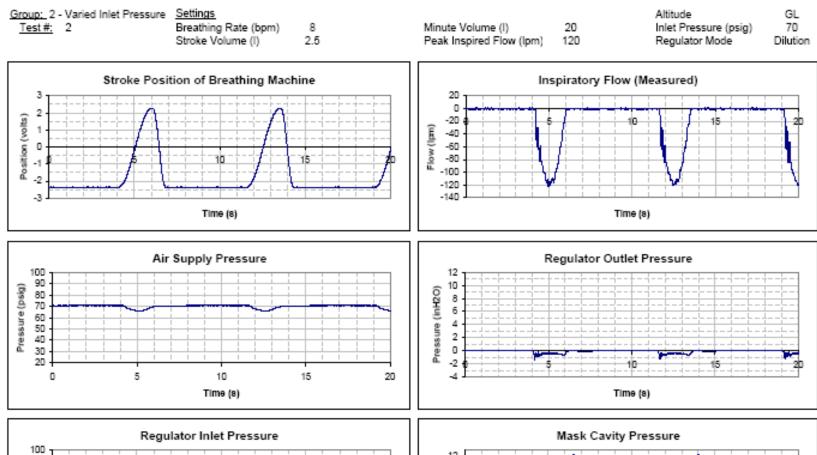
Empty cells: baseline (bold) values apply

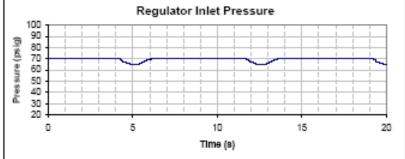
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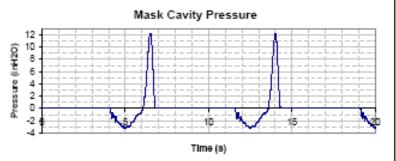
	I I	M	P _{in}	Н	R	Favo	F _{pk-in}
Series	Test #		(psig)	(Kft)	(bpm)	(lpm)	(lpm)
1 Baseline	1	D	70	GL	15	20	120
2	1	D	70	GL	15	20	120
Supply	2				8		
Pressure	3		4.0		22		
	4		40				
	5		!		8		
	6 7		¦		22		
	8		i		22	5	30
	9		i			37.5	225
	10		i				80
	11		i				200
	12		100				
	13		1				
	14				8		
	15		ļ		22		
	16		ļ ļ			5	30
	17		ļ ļ		-	37.5	225
	18		!				80
3	19 1	D	70	GL	15	20	200 120
Mode	2	В	70	GL	8	20	120
Wode	3				22		
	20	100%					
	21	I			8		
	22	i i			22		
	23					5	30
	24					37.5	225
	25						80
	26	Ţ					200
4	1	D	70	GL	15	20	120
Altitude	2				8 22		
	27			7.5	22		
	28			7.3 I	8		
	29			i	22		
	30			1		5	30
	31			i		37.5	225
	32			İ			80
	33			Ì			200
	34			15			
	35				8		
	36			ļ	22		
	37			[5 27.5	30
	38			[37.5	225
	39 40			1			80 200
	40						∠00

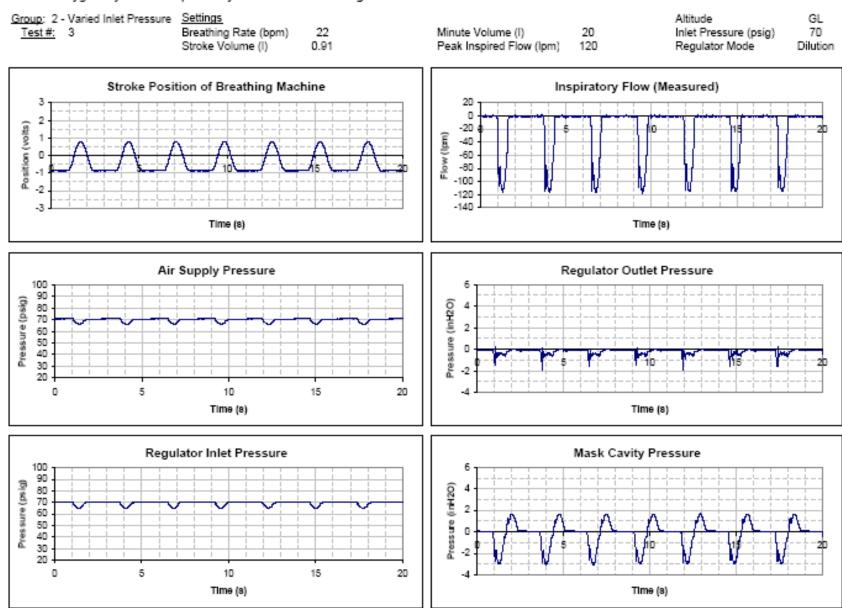
Series	Test #	М	P _{in} (psig)	H (Kft)	R (bpm)	F _{ava} (lpm)	F _{pk-in} (lpm)
4 (con't)	41		(1) - 517	30	X-1/-/	11 /	` '
Altitude	42			1	8		
	43			Ì	22		
	44			Ì		5	30
	45			Ì		37.5	225
	46			Ì			80
	47			İ			200
	48			45			
	49			1	8		
	50			1	22		
	51			1		5	30
	52			1		37.5	225
	53			1			80
	54						200
5	1	D	70	GL	15	20	120
Multiple	2				8		
Extremes	3				22		
	55		40	7.5	8	5	50
	56					20	200
	57			I	22	5	50
	58					40	250
	59			45	8	5	20
	60			I		20	80
	61				22	5	20
	62					40	160
	63	100%		7.5	8	5	50
	64			1		20	200
	65		l	1	22	5	50
	66		l			40	250
	67			45	8	5	20
	68					20	80
	69		ļ	ļ	22	5	20
	70					40	160
6	71				8	5	30
Breathing	72				!	10	60
Profile	2					20	120
	73					5	30
	74	_		6.	4-	10	60
	1	D	70	GL	15	20	120
	75 70					30	180
	76 77					37.5	225
	77					5	20
	78 70					20	80
	79					37.5	150
	80					5	50
	81				00	20	200
	82				22	10	60
	3					20	120
	83					30	180
	84					40	250

CF 100 Oxygen System	Compatability Test - NAC	ES Configuration				
Group: 1 - Baseline _Test#: 1	<u>Settings</u> Breathing Rate (bpm) Stroke Volume (I)	15 1.33	Minute Volume (I) Peak Inspired Flow (Ipm)	20 120	Altitude Inlet Pressure (psig) Regulator Mode	GL 70 Dilution
1	Position of Breathing Mach	. I	piratory Flow (N	Measured)		
(silov) noitie of a second silov of a second sil	Time (s)	15/	20 0 -20 \$ 5 (a) -40 -60 -80 -100 -120 -140	Time (s	15	20
100 90 90 80 70 60 50 30 20 0 5	Air Supply Pressure	15 20	6 (OZHuj) amssaud	egulator Outlet I	15 1	
					,	
100 90 90 80 70 90 80 80 70 90 90 90 90 90 90 90 90 90 90 90 90 90	Regulator Inlet Pressure	15 20	6 (OZHII) 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	Mask Cavity Pro	essure	100
	Time (s)			Time (s	1)	







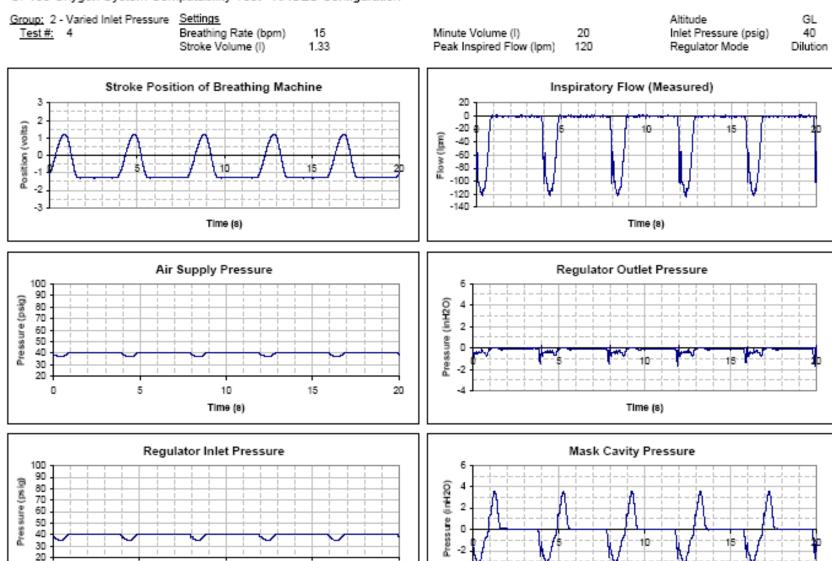


CF188 Oxygen System Compatability Test - NACES Configuration

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Time (s)

15

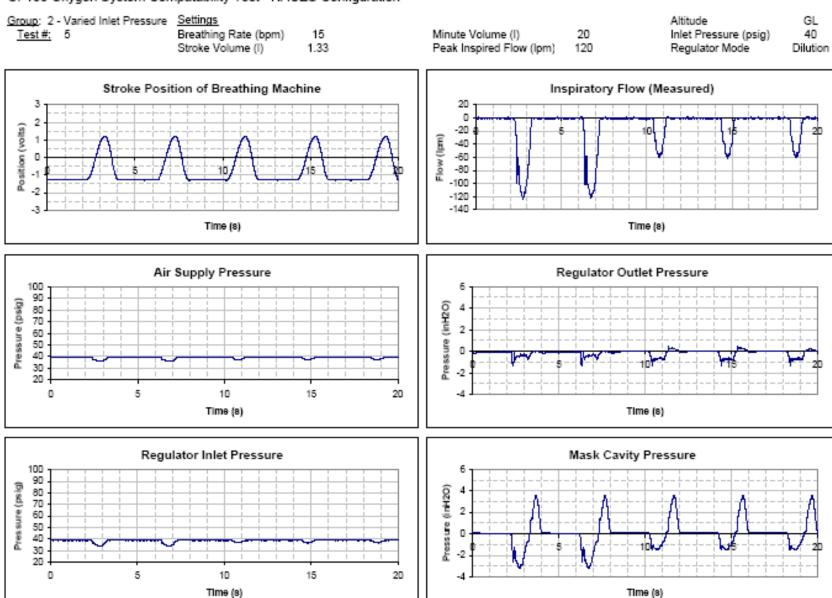


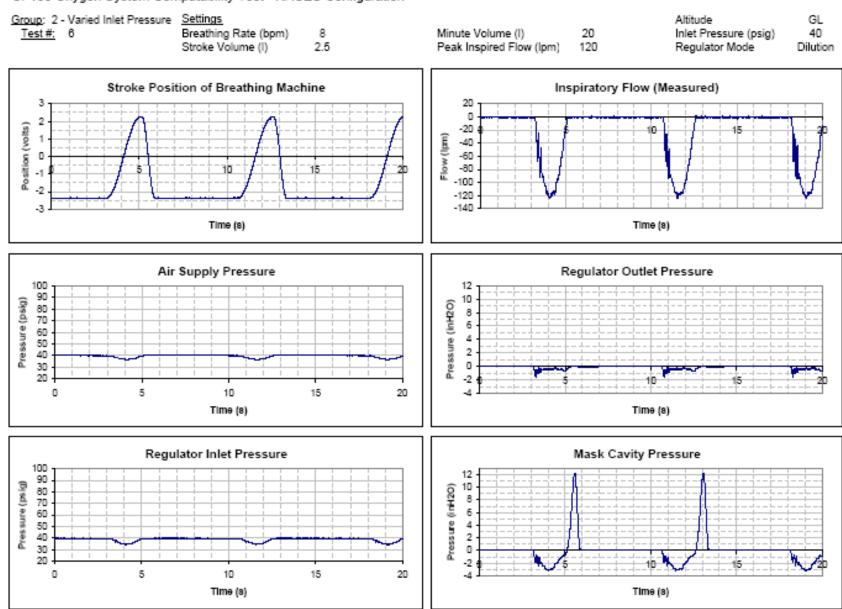
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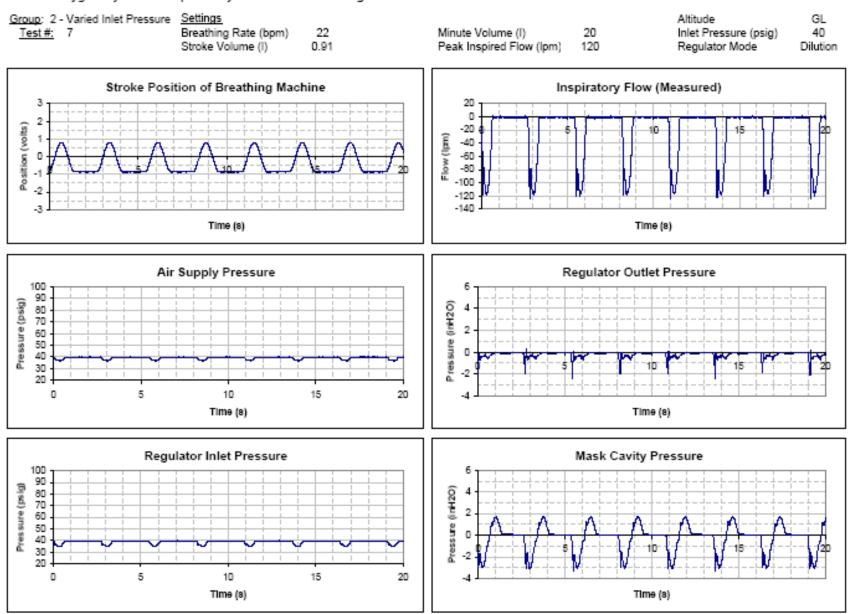
Time (s)

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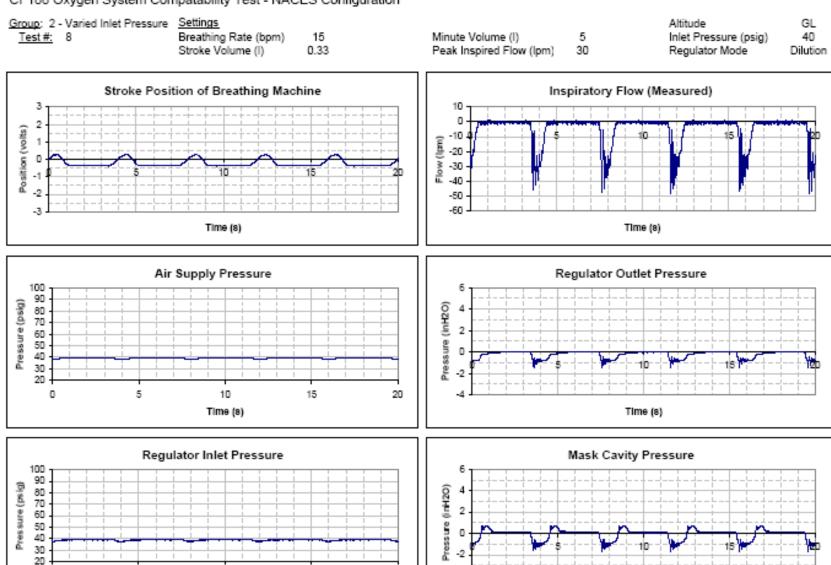
CF188 Oxygen System Compatability Test - NACES Configuration

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Time (s)

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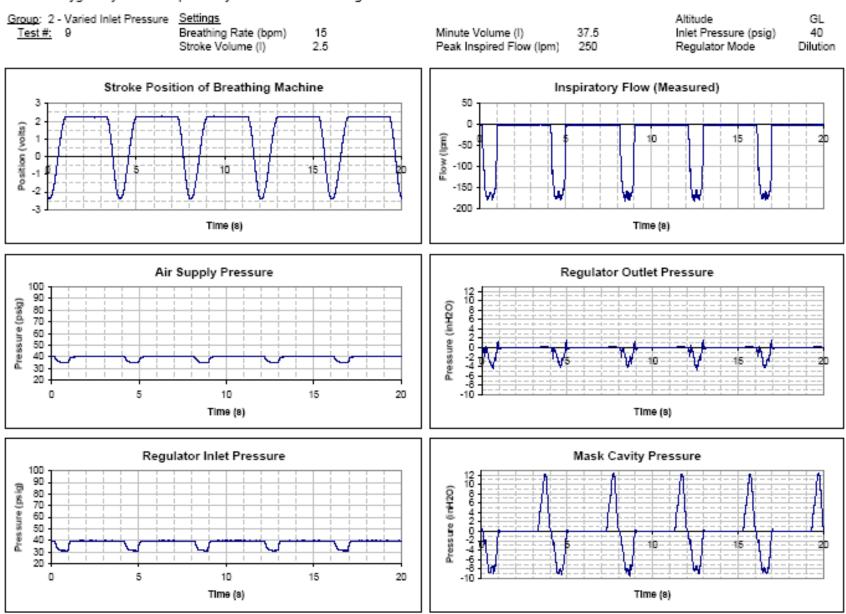
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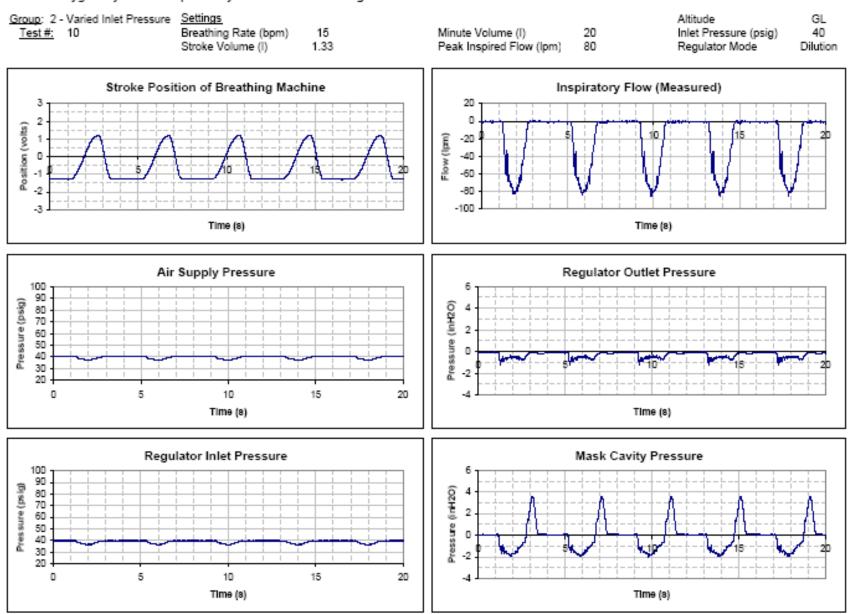


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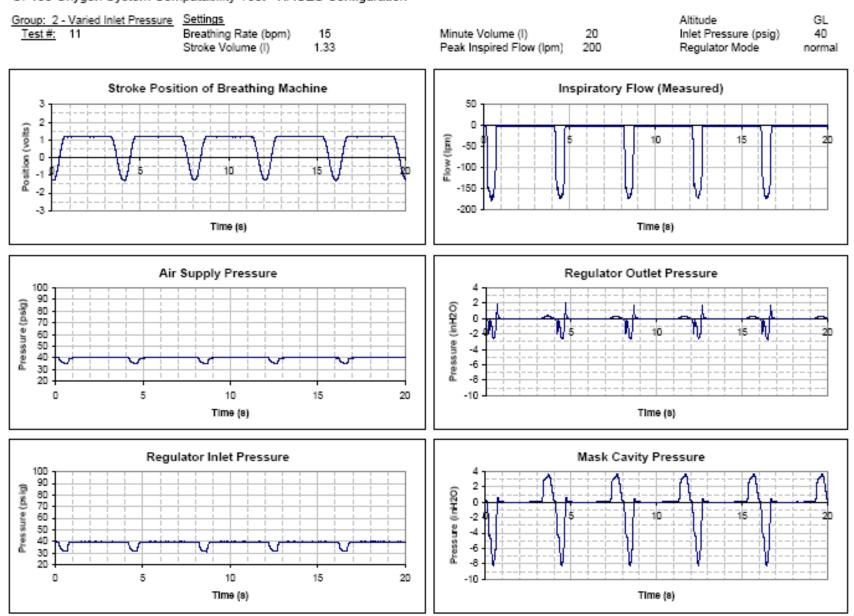
Time (s)

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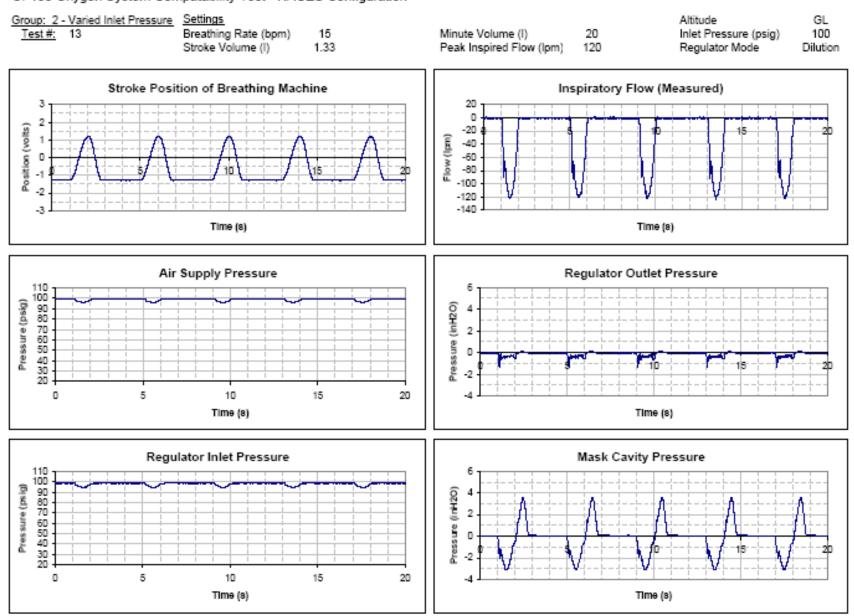
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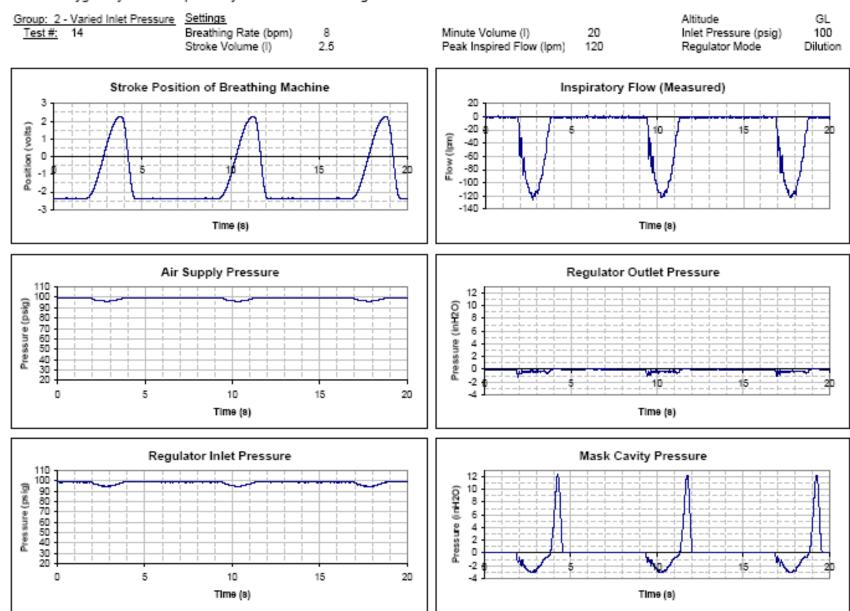
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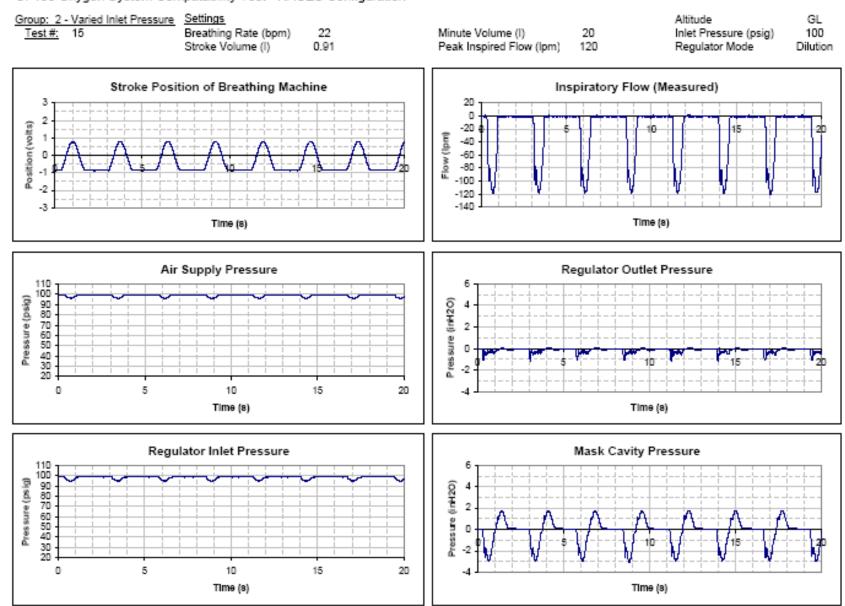
Group: 2 - Varied Inlet Pressure Settings Test #: 12 Breathing Rate (bpm) 15 Stroke Volume (I) 1.33	Minute Volume (I) 20 Inlet Pressure (psig) 100 Peak Inspired Flow (Ipm) 120 Regulator Mode Dilution
Stroke Position of Breathing Machine 3 2 1 8 9 1 1 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 20 -20
Air Supply Pressure 110 100 90 90 970 90 60 90 90 90 100 100 100 100 100 100 100 1	Regulator Outlet Pressure (OZHU) 2 Time (8)
Regulator Inlet Pressure 110 100 100 100 100 100 100 100 100 1	Mask Cavity Pressure 6 2 2 3 0 10 11 10 11 11 11 11 11 11 11 11 11 1

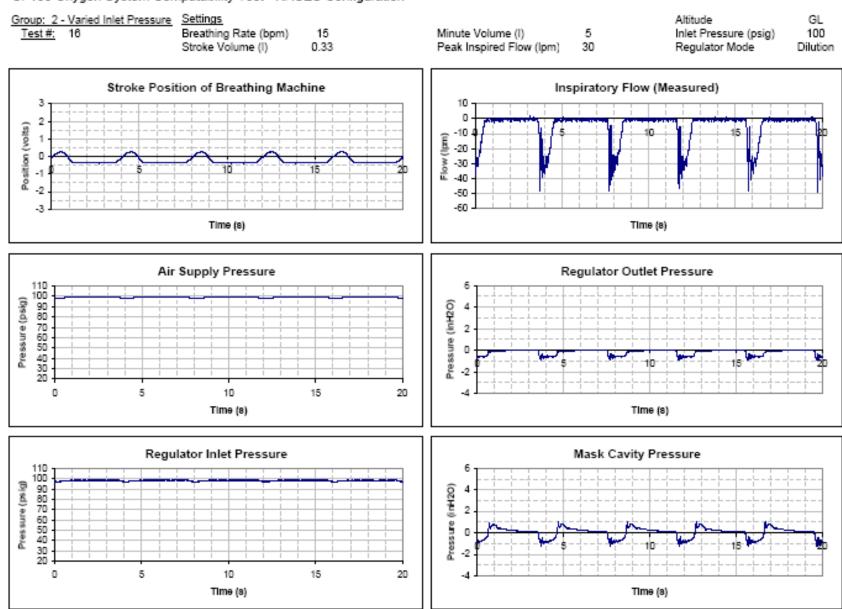
CF188 Oxygen System Compatability Test - NACES Configuration



CF188 Oxygen System Compatability Test - NACES Configuration

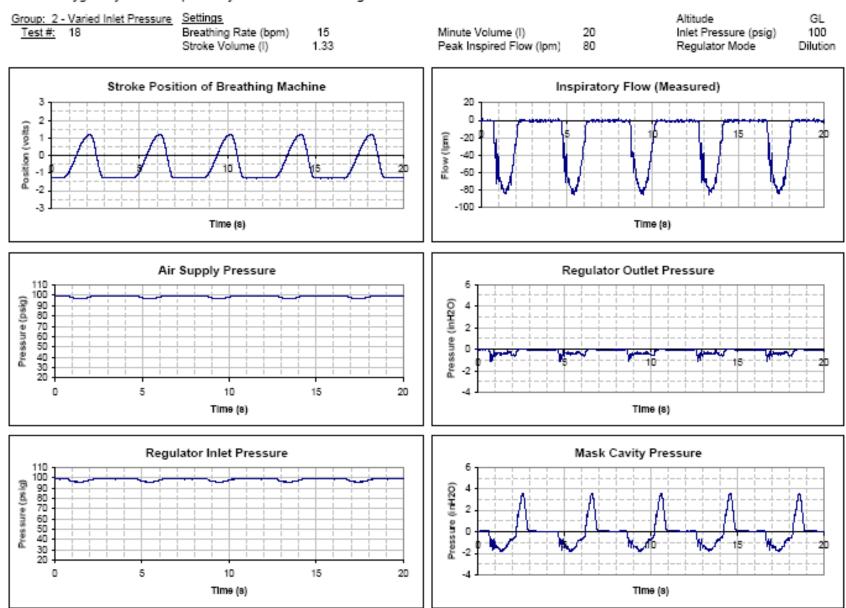




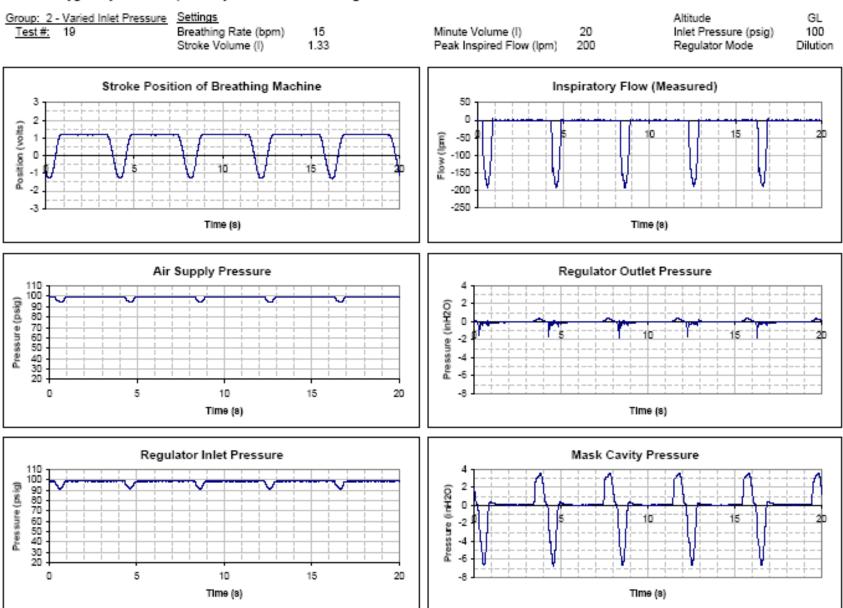


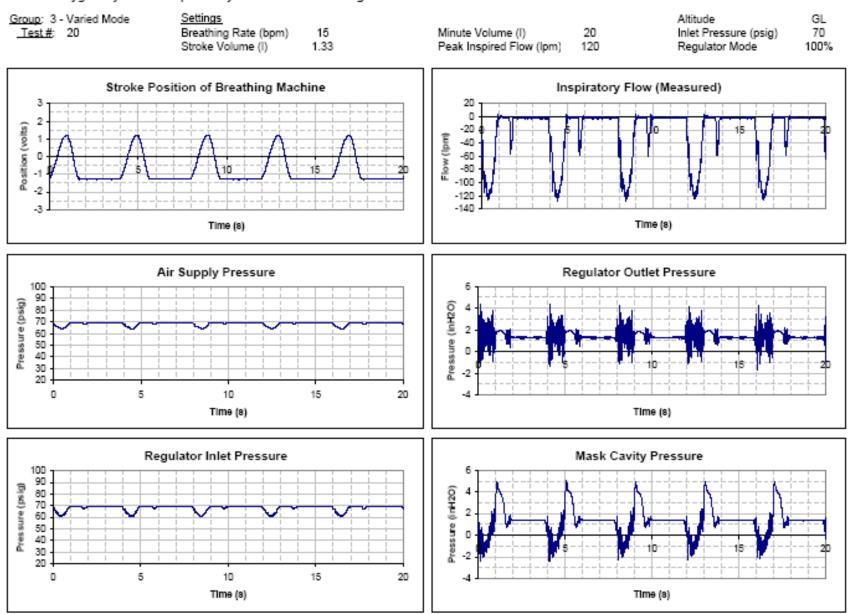
CF188 Oxygen System Compatability Test - NACES Configuration

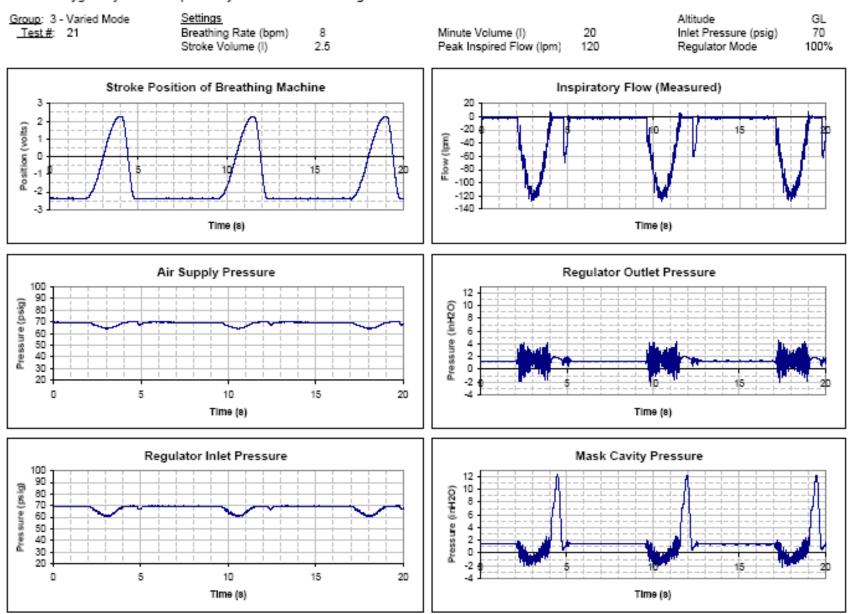
Group: 2 - Varied Inlet Pressure Settings Test #: 17 Breathing Rate (bpm) 15 Stroke Volume (I) 2.5	Minute Volume (I) 37.5 Inlet Pressure (psig) 100 Peak Inspired Flow (Ipm) 250 Regulator Mode Dilution
Stroke Position of Breathing Machine 3 2 1 3 3 4 3 1 1 3 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 15
Air Supply Pressure 110 100 100 90 70 100 60 80 50 10 15 20 Time (a)	Regulator Outlet Pressure OCHU) enseed Time (s)
Regulator Inlet Pressure 110 90 90 70 70 60 40 30 20 0 5 10 15 20 Time (s)	Mask Cavity Pressure 12 10 86 42 10 10 10 10 10 10 10 10 10 10 10 10 10

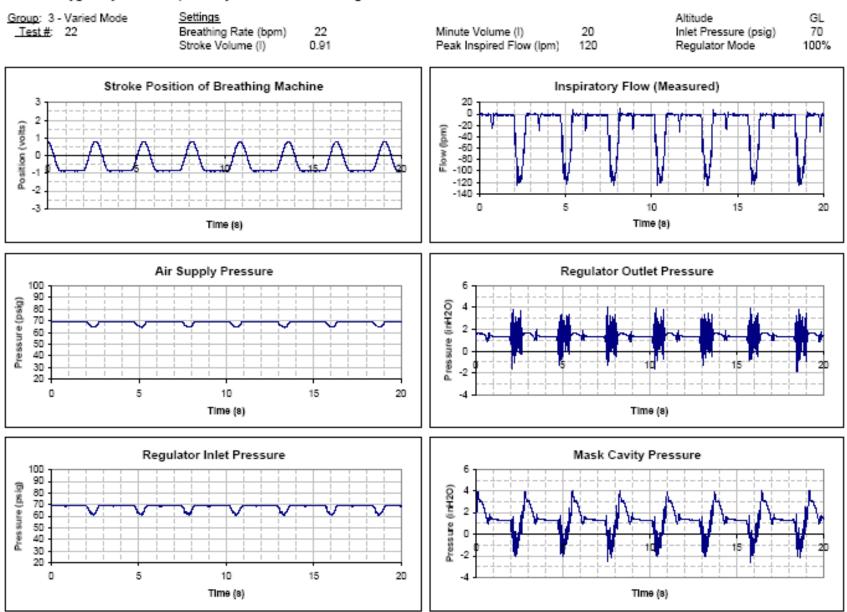


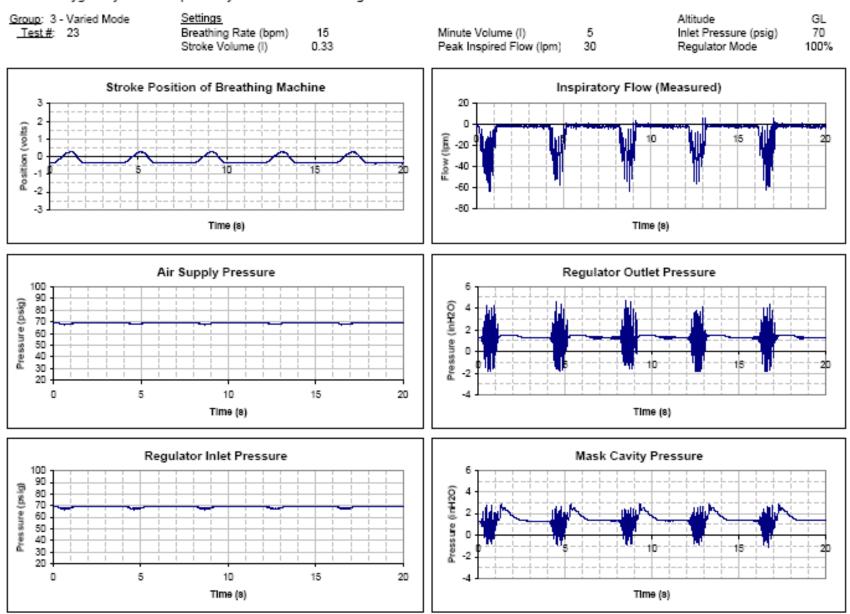
CF188 Oxygen System Compatability Test - NACES Configuration



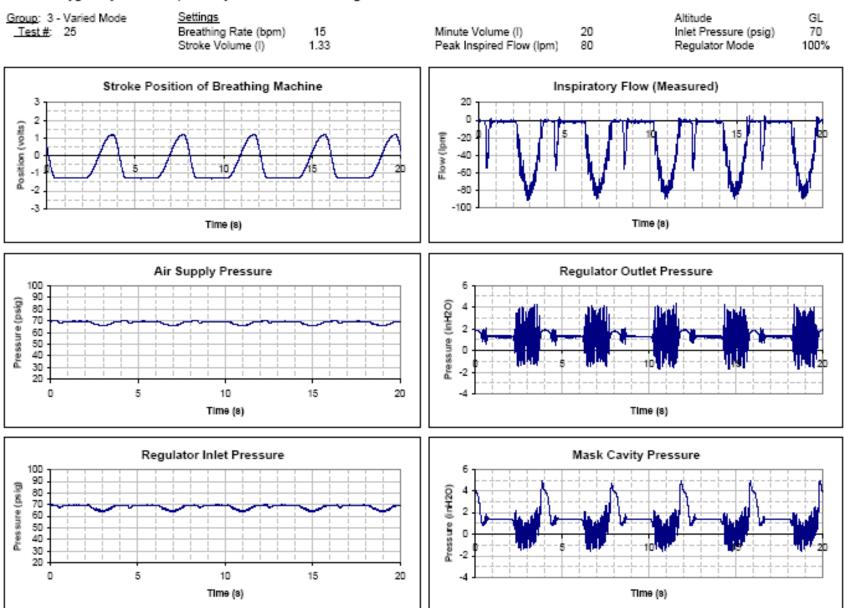


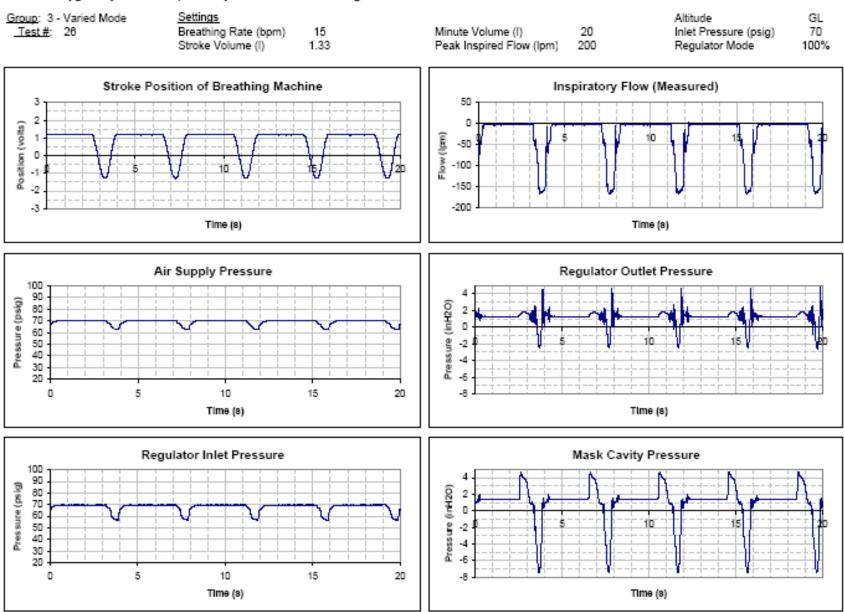


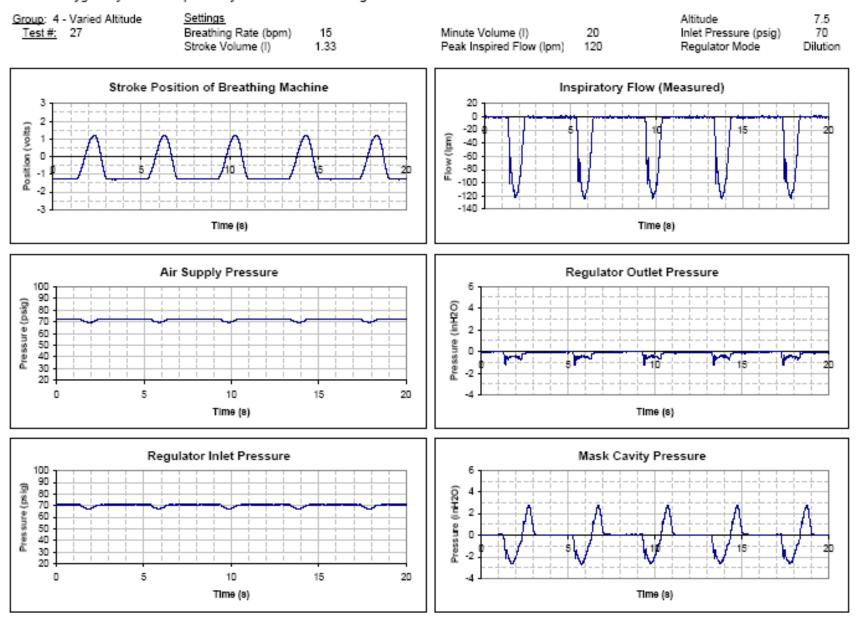


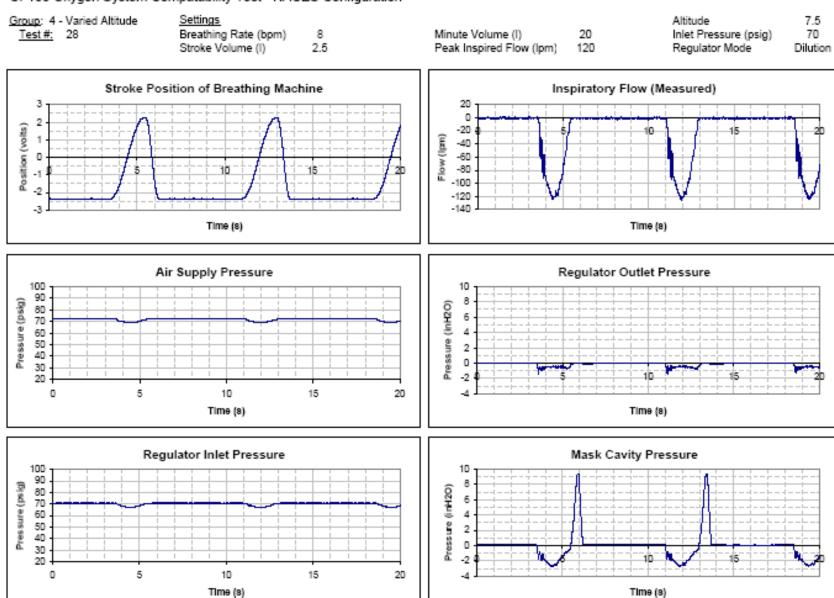


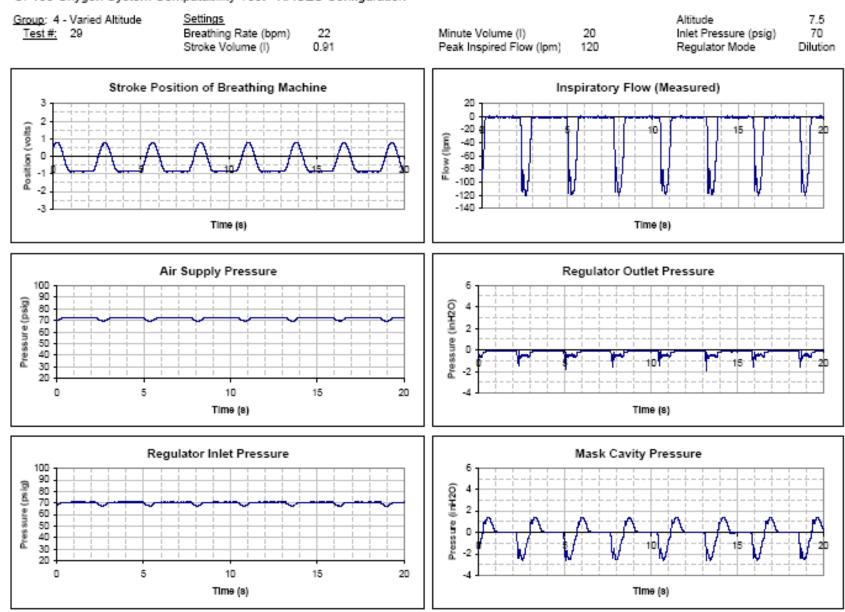
Group: 3 - Varied Mode Settings _Test #: 24 Breathing Rate (bpm) 15 Stroke Volume (I) 2.5	Minute Volume (I) 37.5 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 250 Regulator Mode 100%
Stroke Position of Breathing Machine 3 2 1 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 50 50 50 50 50 50 70 Time (8)
Air Supply Pressure 100 90 80 70 60 70 30 20 0 5 10 15 20 Time (s)	Regulator Outlet Pressure (OZHII) answer Time (s)
Regulator Inlet Pressure 100	Mask Cavity Pressure

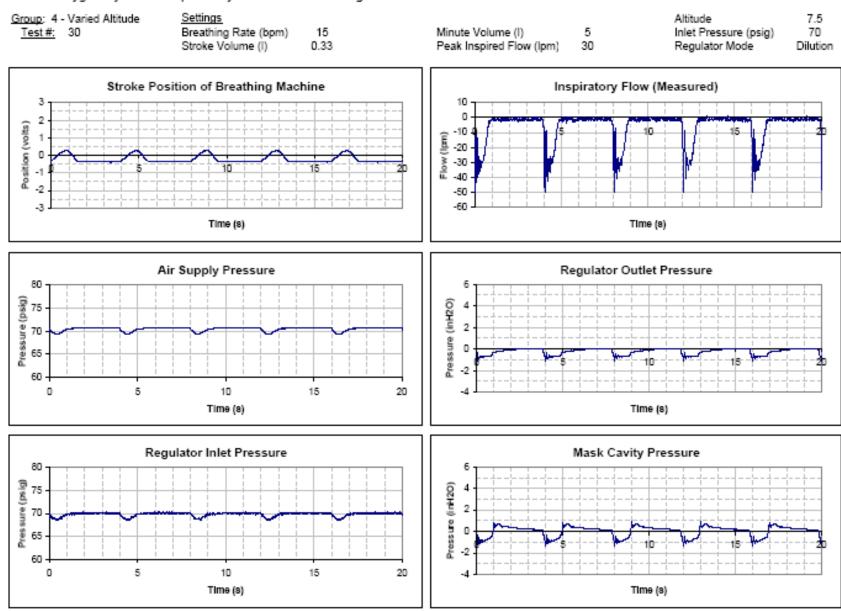












CF188 Oxygen System Compatability Test - NACES Configuration

10

Time (s)

15

CF188 Oxygen System Compatability Test - NACES Configuration			
Group: 4 - Varied Altitude Settings Test #: 31 Breathing Rate (bpm) 15 Stroke Volume (I) 2.5	Minute Volume (I) 37.5 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 250 Regulator Mode Dilution		
Stroke Position of Breathing Machine	Inspiratory Flow (Measured)		
3 2 1 1 8 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	(E) -50		
Air Supply Pressure	Regulator Outlet Pressure		
100 90 90 70 9 50 9 40 9 40 9 40 9 40 9 40 9 40 9 40 9 4	10 8 6 4 2 2 5 10 15 20 4 6 8		
Time (a)	Time (8)		
Regulator Inlet Pressure	Mask Cavity Pressure		

20

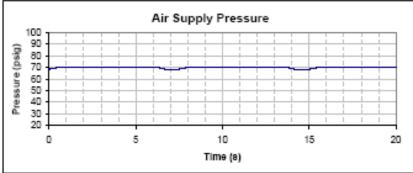
Time (8)

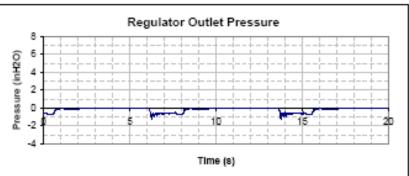
Group: 4 - Varied Altitude Settings Test #: 32 Breathing Rate (bpm) 15 Stroke Volume (I) 1.33	Minute Volume (I) 20 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 80 Regulator Mode Dilution
Stroke Position of Breathing Machine 3 2 1 5 1 1 2 1 1 2 1 Time (s)	Inspiratory Flow (Measured) 20 20 20 3 3 40 60 -80 -100 Time (8)
Air Supply Pressure 100 90 90 60 70 60 30 20 0 5 10 15 20 Time (a)	Regulator Outlet Pressure OOUT 2 Property of the control of the
Regulator Inlet Pressure 100	Mask Cavity Pressure 6 4 2 2 4 Time (s)

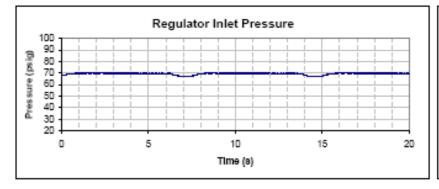
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Stroke Position of Breathing Machine 3 2 1 8 9 1 0 -2 -3 Time (s)	Inspiratory Flow (Measured) 10
Air Supply Pressure 100 90 100 90 100 90 100 100 100 100 1	Regulator Outlet Pressure OCHU OCHU Time (8)
Regulator Inlet Pressure 100 90 80 70 60 40 30 20 0 5 10 15 20 Time (8)	Mask Cavity Pressure 4 2 4 5 10 15 20 Time (s)

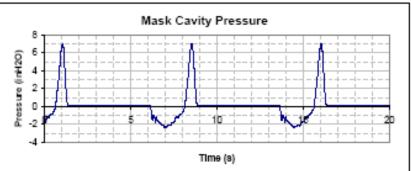
CF 100 Oxygen System Con	npatability Test - NAC	25 Configuration				
Group: 4 - Varied Altitude Test #: 34	Settings Breathing Rate (bpm) Stroke Volume (I)	15 1.33	Minute Volume (I) Peak Inspired Flow (Ipm)	20 120	Altitude Inlet Pressure (psig) Regulator Mode	15 70 Dilution
Stroke Position 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Time (s)	hine	20 0 -20 0 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	piratory Flow (N	15	20
Air 100 90 90 70 90 60 50 40 40 20 0 5	Supply Pressure 10 Time (8)	15 20	(OZHu) amssau 2	egulator Outlet F		20
Regu 100 90 80 70 90 60 50 40 30 0 5	lator Inlet Pressure	15 20	6 (OZHai) en company	Mask Cavity Pre	A	20

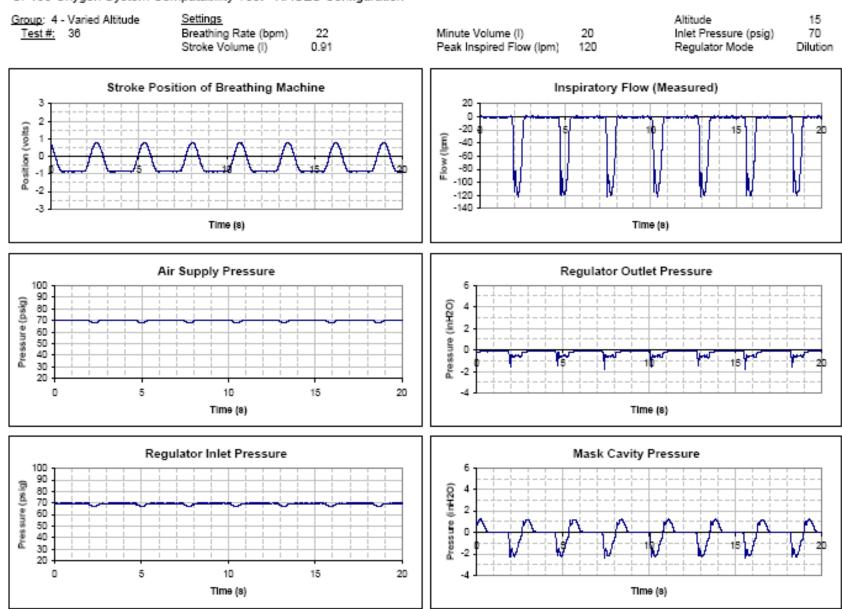
Group: 4 - Varied Altitude Test #: 35	<u>Settings</u> Breathing Rate (bpm) Stroke Volume (I)	8 2.5	Minute Volume (I) Peak Inspired Flow (Ipm)	20 120	Altitude Inlet Pressure (psig) Regulator Mode	15 70 Dilution
	osition of Breathing Mac	hine	11	spiratory Fl	ow (Measured)	
Position of the state of the st		/15	20 -20 0 -20 0 -40 -40 -60 -80 -100 -120 -140	V	10 15/	20
	Time (s)			•	Time (a)	

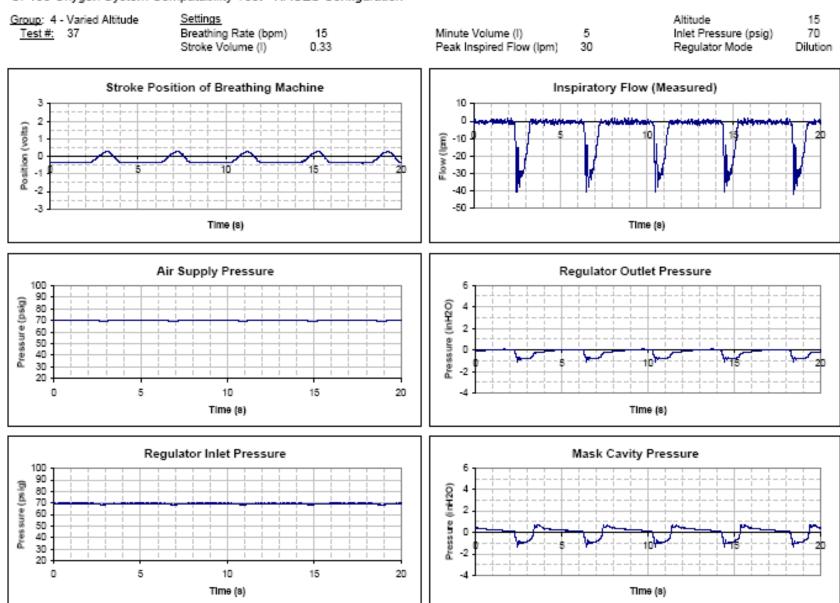






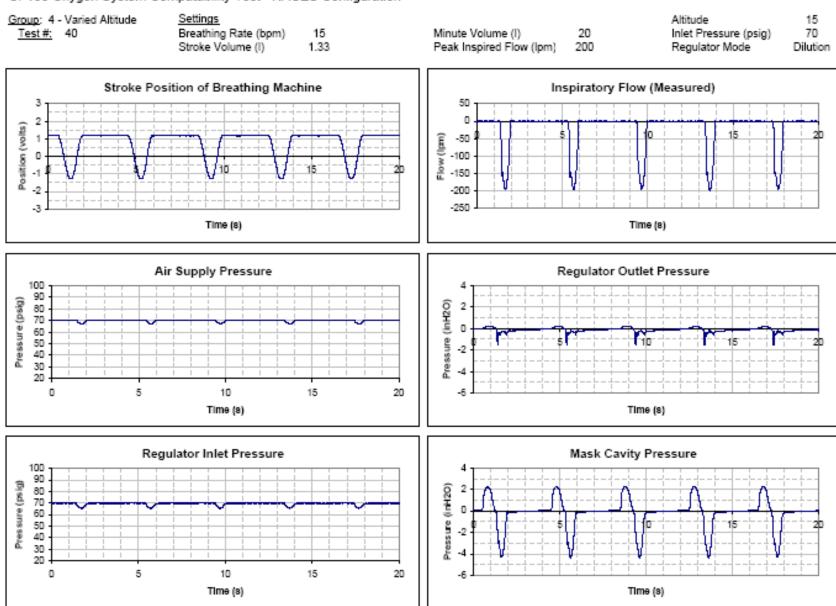




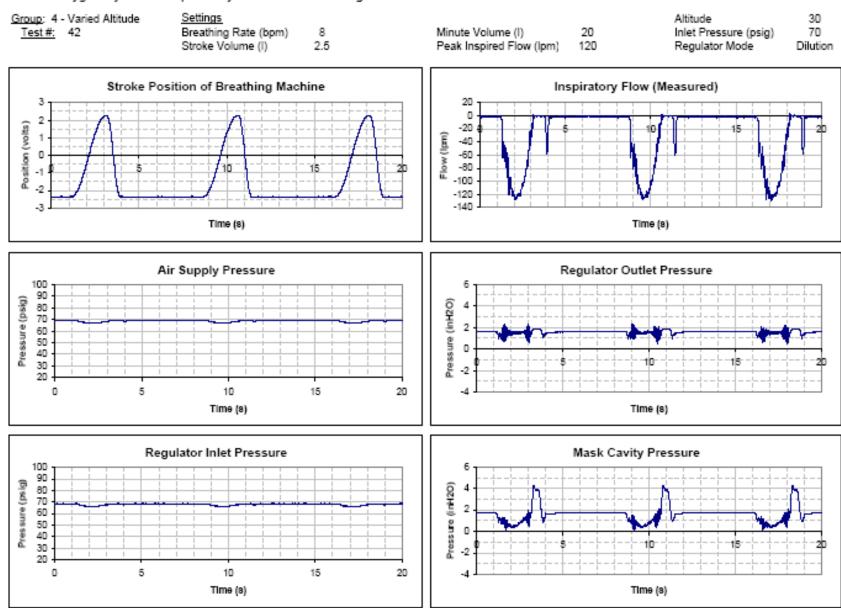


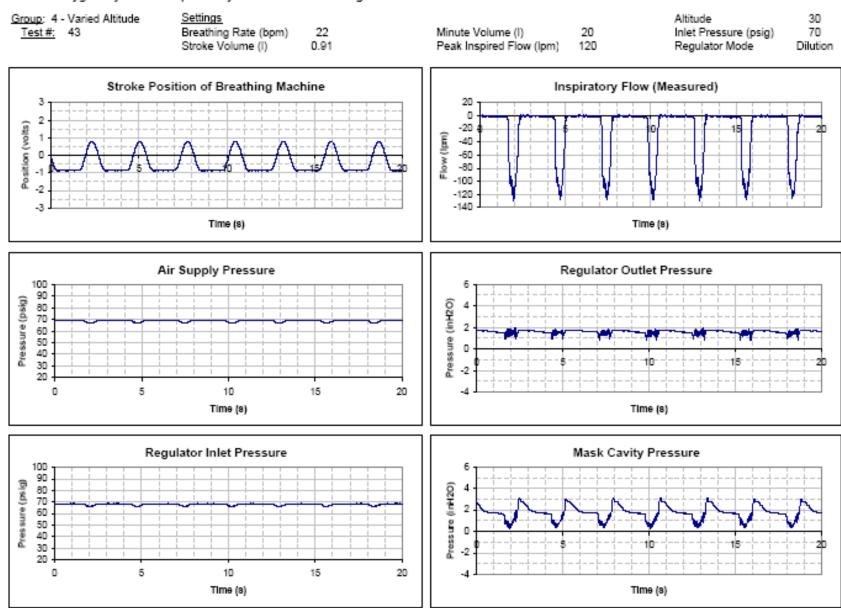
Group: 4 - Varied Altitude Test #: 38 Breathing Rate (bpm) 15 Stroke Volume (i) 2.5 Minute Volume (i) 37.5 Inlet Pressure (psig) 70 Peak Inspired Flow (ipm) 250 Regulator Mode Dilution Stroke Position of Breathing Machine Stroke Position of Breathing Machine	CF188 Oxygen System C	Compatability Test - NAC	ES Configuration				
Air Supply Pressure Regulator Outlet Pressure Regulator Inlet Pressure		Breathing Rate (bpm)	15 2.5			Inlet Pressure (psig)	70
Air Supply Pressure Regulator Outlet Pressure Regulator Inlet Pressure	3	osition of Breathing Mac	hine	50 7	spiratory Flow (N	fleasured)	
Air Supply Pressure 100	sign 1 (o) 1		15 20	-50 0 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5		15	20
100 90 90 90 90 90 90 90		Time (s)			Time (s	3)	
100 90 80 60 70 90 90 90 90 90 90 90 90 90 90 90 90 90	100 90 90 88 80 70 91 60 92 40 40 20	10	15 20	8 6 4 4 2 0 5 5 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6		15	
0 5 10 15 20	100	gulator Inlet Pressure		6	Mask Cavity Pro	essure	
	20		15 20	-01	Time (s)	20

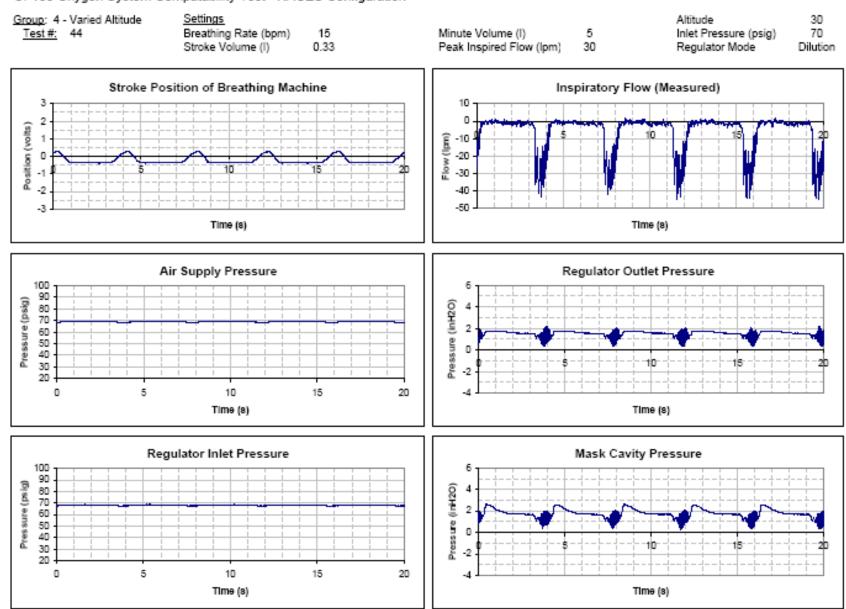
Group: 4 - Varied Altitude Settings Test #: 39 Breathing Rate (bpm) 15 Stroke Volume (I) 1.33	Minute Volume (I) 20 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 80 Regulator Mode Dilution
Stroke Position of Breathing Machine 3 2 1 8 9 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 20 -20 -40 -60 -80 -100 Time (8)
Air Supply Pressure 100	Regulator Outlet Pressure 6 4 2 2 4 Time (8)
Regulator Inlet Pressure 100	Mask Cavity Pressure 6 4 2 2 3 3 4 Time (s)



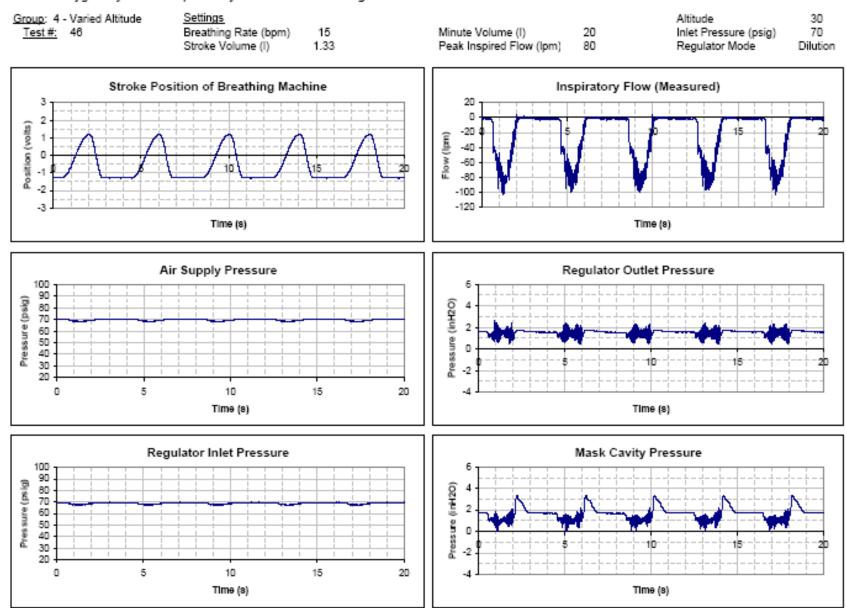
Group: 4 - Varied Altitude Test#: 41	Settings Breathing Rate (bpm) Stroke Volume (I)	15 1.33	Minute Volume (I) Peak Inspired Flow (Ipm)	20 120	Altitude Inlet Pressure (psig) Regulator Mode	30 70 Dilution
Stroke Pe	Time (s)	hine /15	20 0 -20 0 S (4.0 -40 -40 -100 -120 -160 -160	spiratory Flow	(Measured)	20
100 90 80 70 50 50 30 20 0 5	Air Supply Pressure	15 20	6 (OZHui) emssed 2 4		et Pressure	20
Re 100 90 80 80 70 90 90 90 90 90 90 90 90 90 90 90 90 90	egulator Inlet Pressure	15 20	6 (0HZ) 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		Pressure	20

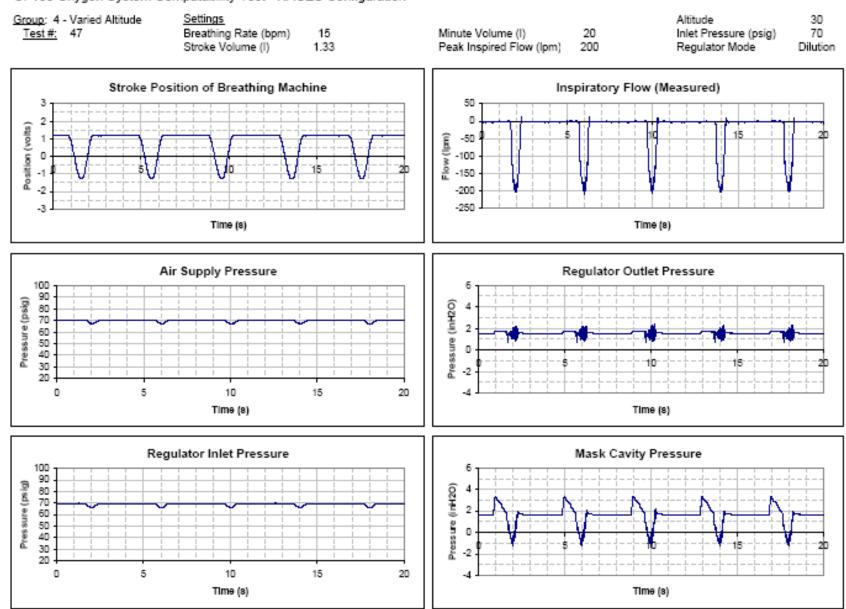


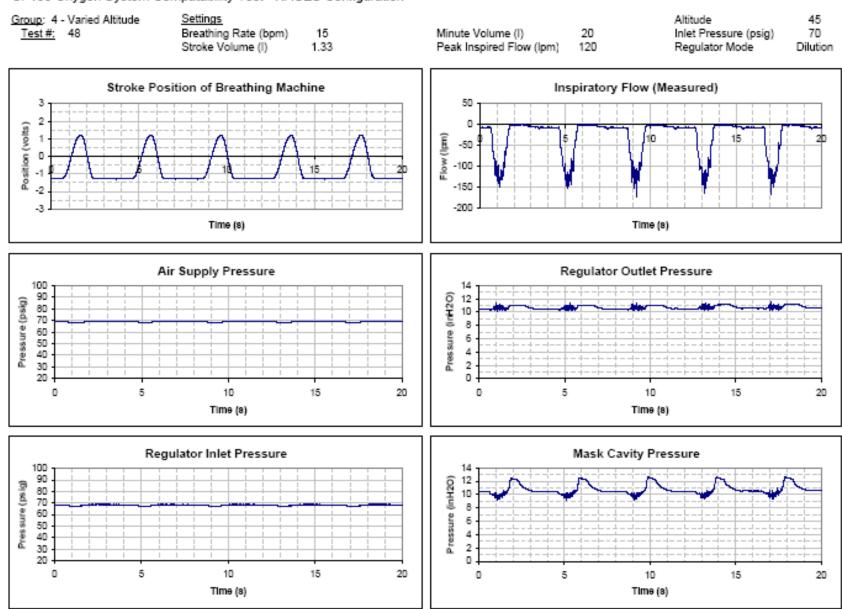




Group: 4 - Varied Altitude Settings Test #: 45 Breathing Rate (bpm) 15 Stroke Volume (I) 2.5	Minute Volume (I) 37.5 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 250 Regulator Mode Dilution
Stroke Position of Breathing Machine 3 2 3 1 3 1 3 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 50 -50 -50 -100 -150 -200 -250 -300 Time (a)
Air Supply Pressure 100 90 90 60 70 60 30 20 0 5 10 15 20 Time (a)	Regulator Outlet Pressure OCHU 2 Inseed to the control of the c
Regulator Inlet Pressure 100 90 80 70 60 40 30 20 5 10 15 20 Time (s)	Mask Cavity Pressure 6 4 2 2 -2 -4 Time (s)







CF188 Oxygen System Compatability Test - NACES Configuration

Group: 4 - Varied Altitude Settings Test #: 49 Breathing Rate (bpm) 8 Stroke Volume (I) 2.5	Minute Volume (I) 20 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm 120 Regulator Mode Dilution
Stroke Position of Breathing Machine 3 2 1 8 0 4 -2 -3 Time (s)	Inspiratory Flow (Measured) 50 50 50 50 50 50 50 50 70 70
Air Supply Pressure 100 90 90 70 90 60 70 90 50 10 15 20 Time (8)	Regulator Outlet Pressure Regulator Outlet Pressure 14 OCHU 8 4 2 0 5 10 15 20 Time (8)
Regulator Inlet Pressure 100 90 80 70 60 50 40 30 20 0 5 10 15 20 Time (8)	Mask Cavity Pressure 14 (0 12 (10) (10) (10) (10) (10) (10) (10) (10)

Settings Settings	Minute Volume (I) 20 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 120 Regulator Mode Dilution
Stroke Position of Breathing Machine 3 2 1 5 1 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 50 -50 -50 -150 -200 Time (8)
Air Supply Pressure 100 90 60 70 60 50 40 30 20 5 10 15 20 Time (a)	Regulator Outlet Pressure Regulator Outlet Pressure 14 0 12 10 8 6 4 2 0 0 5 10 15 20 Time (8)
Regulator Inlet Pressure 100 90 80 70 60 50 40 30 20 5 10 15 20 Time (s)	Mask Cavity Pressure 14 02 10 10 10 10 10 10 10 10 10 10 10 10 10 1

Group: 4 - Varied Altitude Settings Test #: 51 Breathing Rate (bpm) 15 Stroke Volume (I) 0.33	Minute Volume (I) 5 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 30 Regulator Mode Dilution
Stroke Position of Breathing Machine Stroke Position of Breathing Machine Time (s)	Inspiratory Flow (Measured) (a) -10 -20 -30 -40 -50 Time (a)
Air Supply Pressure 100 90 90 60 70 60 30 20 0 5 10 15 20 Time (a)	Regulator Outlet Pressure 14 12 10 8 6 4 2 0 5 10 15 20 Time (8)
Regulator Inlet Pressure 100 90 80 70 60 50 40 30 20 0 5 10 15 20 Time (8)	Mask Cavity Pressure OHU OHU Time (8)

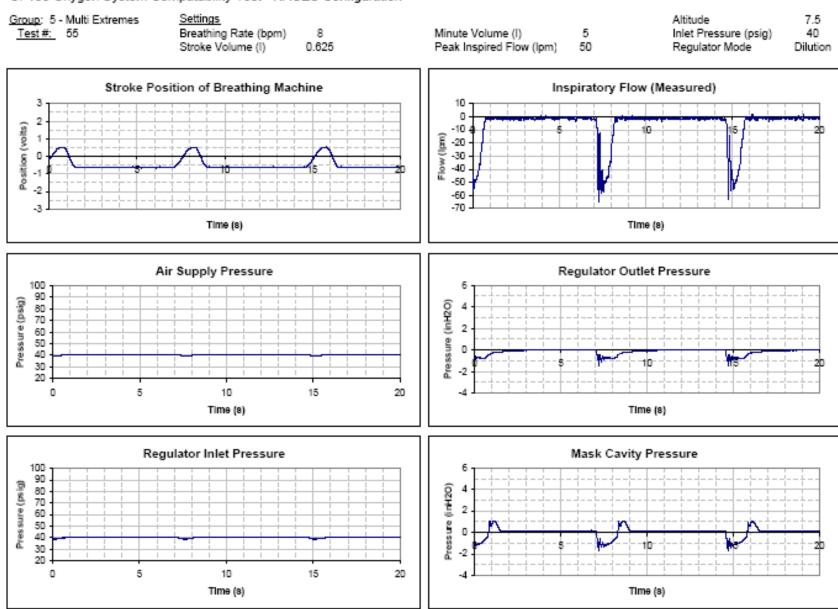
CF188 Oxygen System Compatability Test - NACES Configuration

Group: 4 - Varied Altitude Settings Test #: 52 Breathing Rate (bpm) 15 Stroke Volume (I) 2.5	Minute Volume (I) 37.5 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 250 Regulator Mode Dilution				
Stroke Position of Breathing Machine 3 2 1 5 0 1 4 -2 -3 Time (s)	Inspiratory Flow (Measured) 50 -50 -50 -100 -150 -200 -250 -360 Time (a)				
Air Supply Pressure 100	Regulator Outlet Pressure Regulator Outlet Pressure 14 0 12 10 8 6 4 2 0 0 5 10 15 20 Time (8)				
Regulator Inlet Pressure 100					

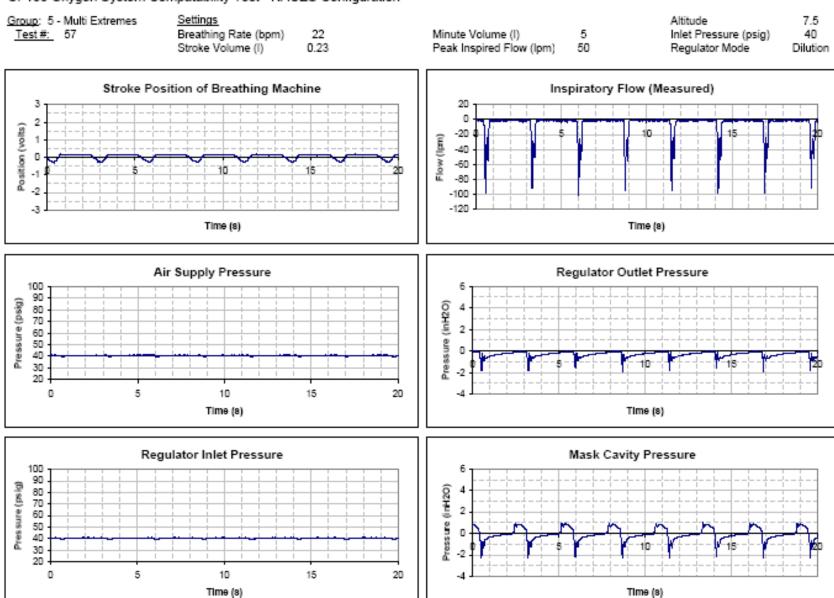
Group: 4 - Varied Altitude Settings Test #: 53 Breathing Rate (bpm) 15 Stroke Volume (I) 1.33	Minute Volume (I) 20 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 80 Regulator Mode Dilution				
Stroke Position of Breathing Machine 3 2 1 8 9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 50 0 10 15 20 Time (a)				
Air Supply Pressure 100 90 60 70 60 50 40 30 20 5 10 15 20 Time (a)	Regulator Outlet Pressure Regulator Outlet Pressure 14 12 10 8 6 4 2 0 5 10 15 20 Time (8)				
Regulator Inlet Pressure 100	Mask Cavity Pressure 14 12 10 10 10 10 10 10 10 10 11 10 15 20 Time (8)				

CF188 Oxygen System Compatability Test - NACES Configuration

Group: 4 - Varied Altitude Settings Test #: 54 Breathing Rate (bpm) 15 Stroke Volume (I) 1.33	Minute Volume (I) 20 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 200 Regulator Mode Dilution				
Stroke Position of Breathing Machine 3 2 3 1 3 1 3 1 1 1 1 1 1 1 1 1 1 1 1	Inspiratory Flow (Measured) 50 0 -50 -50 -50 -50 -50 -50 -50 -50 -				
Air Supply Pressure 100	Regulator Outlet Pressure 14 12 10 8 6 4 2 0 5 10 15 20 Time (8)				
Regulator Inlet Pressure 100	Mask Cavity Pressure 14 12 10 18 8 6 4 2 0 0 5 10 15 20 Time (s)				



Altitude 7.5				
Inspiratory Flow (Measured) 50 -50 -50 -50 -50 -50 -50 -50				
Mask Cavity Pressure 10				



CF188 Oxygen System Compatability Test - NACES Configuration

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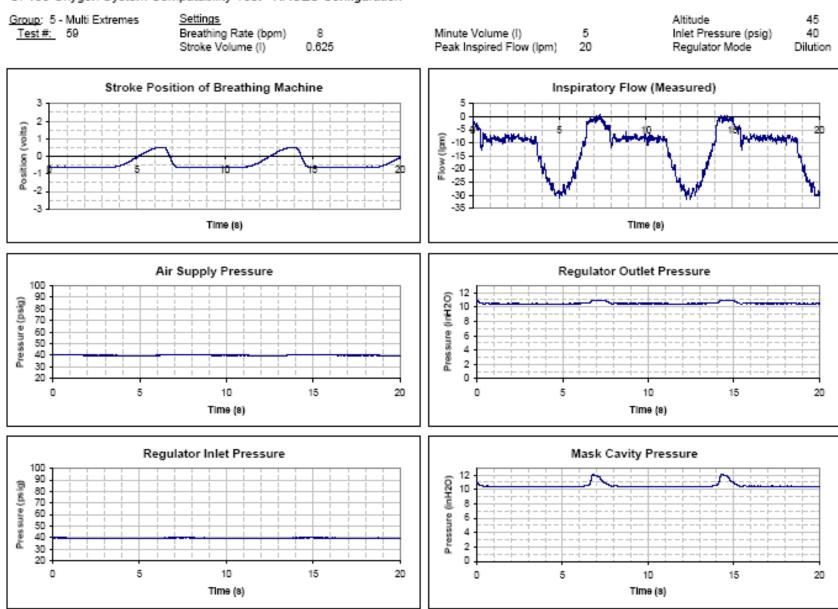
Time (8)

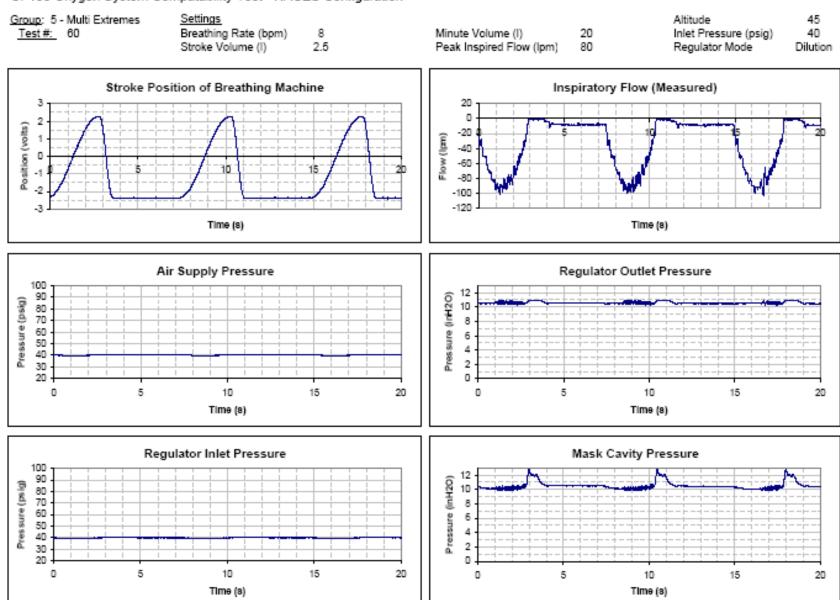
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CF188 Oxygen System Compatability Test - NACES Configuration				
Group: 5 - Multi Extremes Settings Test #: 58 Breathing Rate (bpm) 22 Stroke Volume (I) 1.82	Minute Volume (I) 40 Inlet Pressure (psig) 40 Peak Inspired Flow (Ipm) 250 Regulator Mode Dilution			
Stroke Position of Breathing Machine	Inspiratory Flow (Measured)			
3 2 1 1 0 0 2 -2 -3 Time (s)	50 0 -50 -100 -150 -200 -250 -250 -250 -250 -250 -250 -2			
Air Supply Pressure	Regulator Outlet Pressure			
100 90 80 70 40 30 20 0 5 10 15 20 Time (s)	(OZHU) ans sau 4			
Regulator Inlet Pressure	Mask Cavity Pressure			
100 100 100 100 100 100 100 100 100 100	02 4			

20

Time (a)



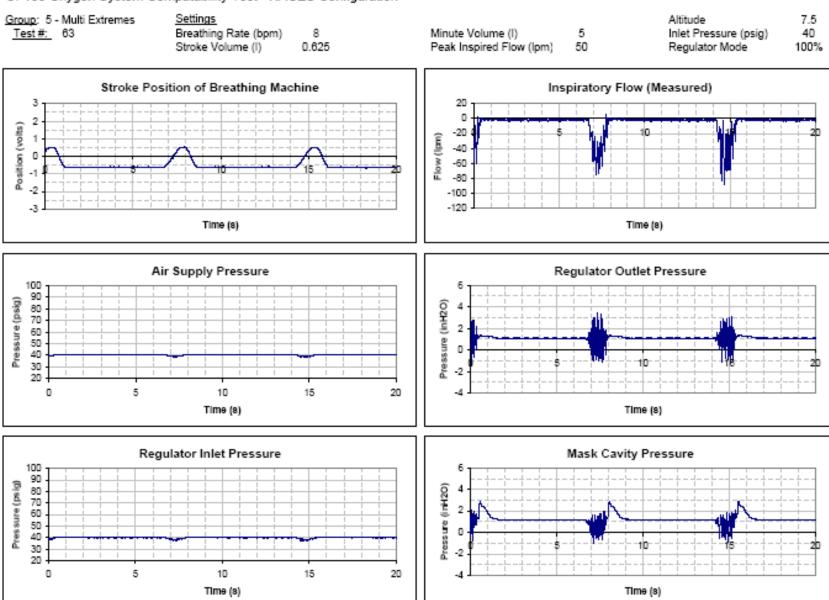


CF188 Oxygen System Compatability Test - NACES Configuration				
Group: 5 - Multi Extremes Settings Test #: 61 Breathing Rate (bpm) 22 Stroke Volume (I) 0.23	Minute Volume (I) 5 Inlet Pressure (psig) 40 Peak Inspired Flow (Ipm) 20 Regulator Mode Dillution			
Stroke Position of Breathing Machine	Inspiratory Flow (Measured)			
(\$\vec{x}{1}\) 1	5 0 -5 -10 -10 -15 -20 -20 -25 -30 -35			
Air Supply Pressure	Regulator Outlet Pressure			
100 90 80 70 60 50 40 30 20 0 5 10 15 20 Time (a)	0 5 10 15 20 Time (s)			
Regulator Inlet Pressure	Mask Cavity Pressure			
100 90 90 80 70 60 90 60 90 90 90 90 90 90 90 90 90 90 90 90 90	12 (OZHU 8 8 9 16 17 18 18 18 18 18 18 18 18 18 18 18 18 18			
Time (s)	Time (s)			

Time (s)

CF188 Oxygen System C	Compatability Test - NAC	ES Configuration				
Group: 5 - Multi Extremes Test #: 62	Settings Breathing Rate (bpm) Stroke Volume (I)	22 1.82	Minute Volume (I) Peak Inspired Flow (Ipm)	40 160	Altitude Inlet Pressure (psig) Regulator Mode	45 40 Dilution
Stroke Position of Breathing Machine			Inspiratory Flow (Measured)			
3 2 (stion) noise of 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	Time (s)		50 0 (iii) 30 -50 No100 -150 -200		Time (8)	20
Air Supply Pressure			Regulator Outlet Pressure			
100 (Bis 80 70 90 90 90 90 90 90 90 90 90 90 90 90 90	10 Time (s)	15 20	0 12 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8		10 15 Time (8)	20
Re 100 90 90 80 70 90 90 90 90 90 90 90 90 90 90 90 90 90	gulator Inlet Pressure		D 12 (0HZ) 6 10 10 10 10 10 10 10 10 10 10 10 10 10	Mask Cavi	ty Pressure	
30 20			2 2			

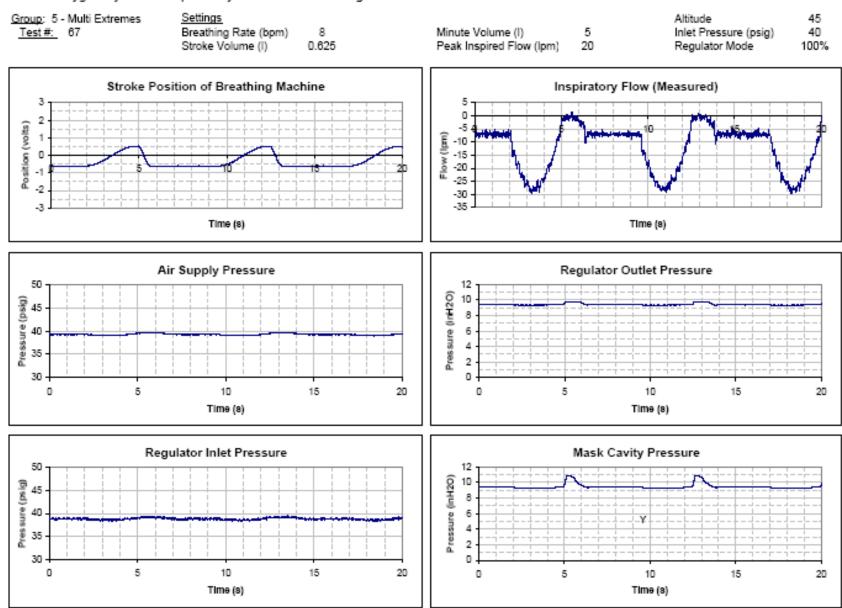
Time (8)



CF188 Oxygen System Compatability Test - NACES Configuration					
Group: 5 - Multi Extremes Settings Test #: 64 Breathing Rate (bpm) 8 Stroke Volume (I) 2.5	Minute Volume (I) 20 Altitude 7.5 Peak Inspired Flow (Ipm) 200 Regulator Mode 100%				
Stroke Position of Breathing Machine	Inspiratory Flow (Measured)				
	(L) -40 -60 -80 -80 -100 -120 -140 -160				
Time (s)	Time (a)				
Air Supply Pressure 100 90 80 70 95 60 40 30 20 5 10 15 20 Time (a)	Regulator Outlet Pressure Option 20				
Regulator Inlet Pressure 100 90 80 70 60 70 40 30 0 5 10 15 20 Time (a)	Mask Cavity Pressure				
Time (8)	Time (a)				

Group: 5 - Multi Extremes Test #: 65	Settings Breathing Rate (bpm) Stroke Volume (I)	22 0.23	Minute Volume (I) Peak Inspired Flow (Ipm)	5 50	Altitude Inlet Pressure (psig) Regulator Mode	7.5 40 100%	
Stroke Position of Breathing Machine Stroke Position of Breathing Machine Stroke Position of Breathing Machine Time (8)			Inspiratory Flow (Measured) 20 20 20 3 5 10 15 15 10 15 17 10 18 18 19 19 10 10 11 15 10 10 11 15 10 10 11 15 10 10 11 15 10 10 11 15 10 10 10 11 10 11 10 11 10 11 10 11 10 11 10 11 10 11 11				
(Bisd) 70 90 60 50 50 50 50 50 50 50 50 50 50 50 50 50	Air Supply Pressure	15 20	Resolution of the control of the con	egulator Outlet I	115		
Re 100 90 80 70 earns seal. 30 20 5	gulator Inlet Pressure 10 Time (8)	15 20	6 (QZ 4 2 2 2 4	Mask Cavity Pro	15	20	

Group: 5 - Multi Extremes Test #: 66	Settings Breathing Rate (bpm) Stroke Volume (I)	22 1.82	Minute Volume (I) Peak Inspired Flow (Ipm)	40 250	Altitude Inlet Pressure (psig) Regulator Mode	7.5 40 100%	
Stroke Position of Breathing Machine 3 2 1 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			Inspiratory Flow (Measured) -50 -50 -100 -150 -200 -5 -50 -10 -150 -200 -200 -200 -200 -200 -200 -200 -2				
100 90 90 80 70 50 50 40 30 20 5	Air Supply Pressure	15 20	(OZHII) ems send	egulator Outlet I	15	20	
Re 100 90 80 70 91 60 80 40 30 0 5	gulator Inlet Pressure	15 20	Pressure (inH20)	Mask Cavity Pro	15	20	



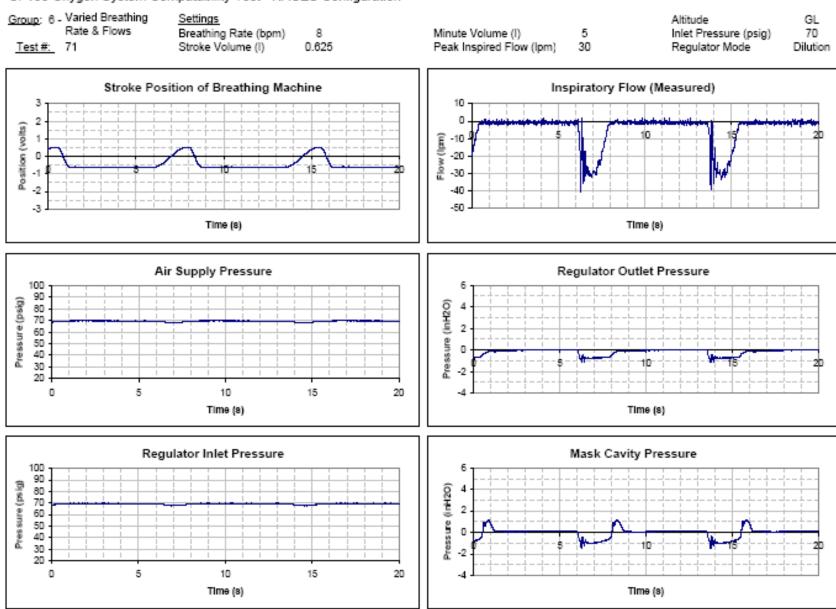
Time (s)

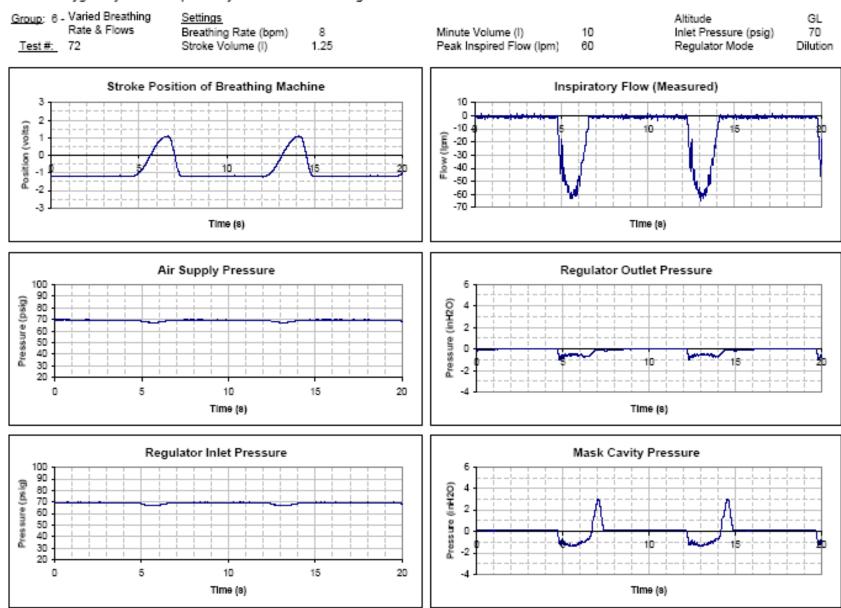
CF188 Oxygen System Compatability Test - NACES Configuration							
<u>Group</u> : 5 - Multi Extremes <u>Test #:</u> 68	Settings Breathing Rate (bpm) Stroke Volume (I)	8 2.5	Minute Volume (I) Peak Inspired Flow (Ipm)	20 80	Altitude Inlet Pressure (psig) Regulator Mode	45 40 100%	
Stroke Position of Breathing Machine Stroke Position of Breathing Machine Time (s)			Inspiratory Flow (Measured) 20 20 30 40 40 40 40 40 100 120 Time (s)				
Air Supply Pressure 100 90 100 90 100 90 100 100 100 100 1			Regulator Outlet Pressure 12				
Reg	ulator Inlet Pressure	15 20	D 5	Mask Cavity P		20	

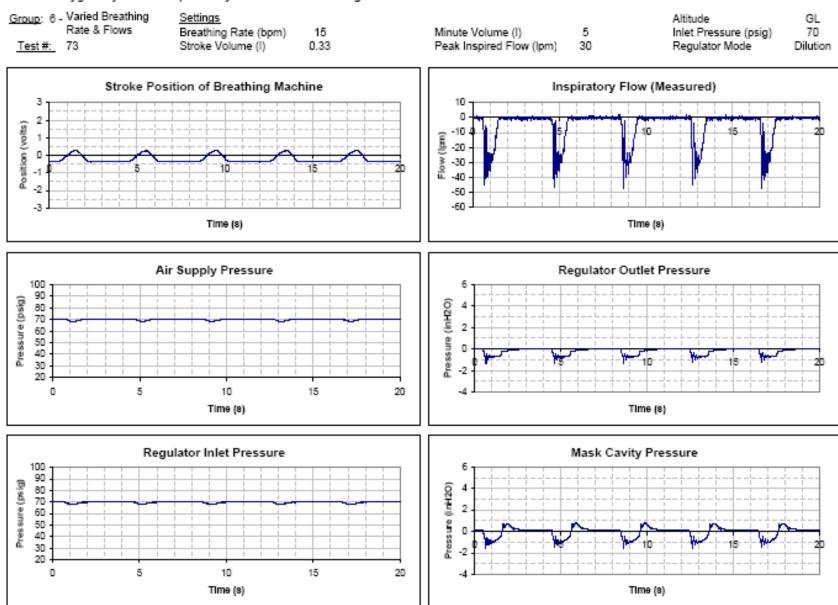
Time (8)

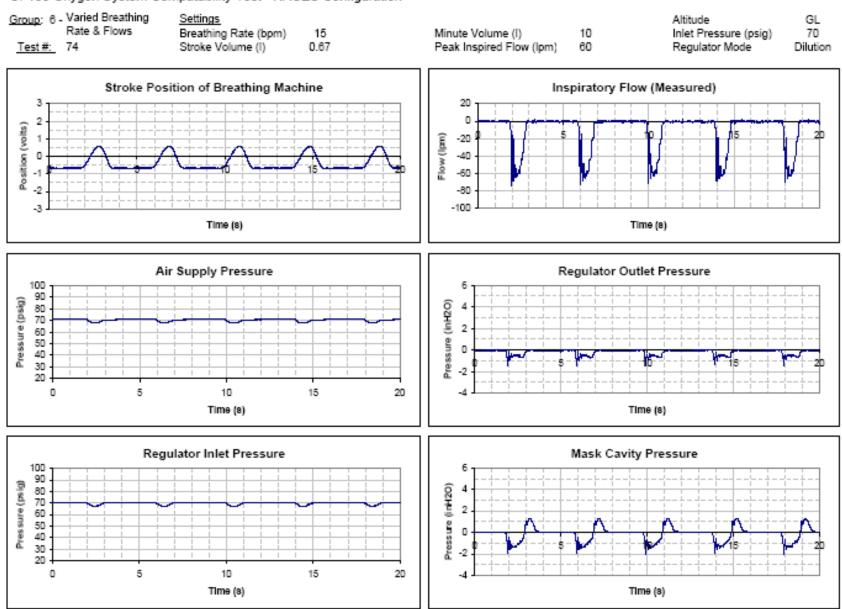
Group: 5 - Multi Extremes Test #: 69	Settings Breathing Rate (bpm) Stroke Volume (I)	22 0.23	Minute Volume (I) Peak Inspired Flow (Ipm)	5 20	Altitude Inlet Pressure (psig) Regulator Mode	45 40 100%	
Stroke Position of Breathing Machine Stroke Position of Breathing Machine Time (s)			Inspiratory Flow (Measured) 5 0 -5 -5 -10 -15 -20 -25 -30 -35 Time (e)				
Air Supply Pressure 100			Regulator Outlet Pressure 12 (0 10 10 8 90 4 2 0 0 5 10 15 20 Time (8)				
Re 100 90 80 80 70 80 60 50 40 30 20 0 5	egulator Inlet Pressure	15 20	12 (OZHuj) 8 8 6 4 2 2 0 0 5	Mask Cavity Pro	15	20	

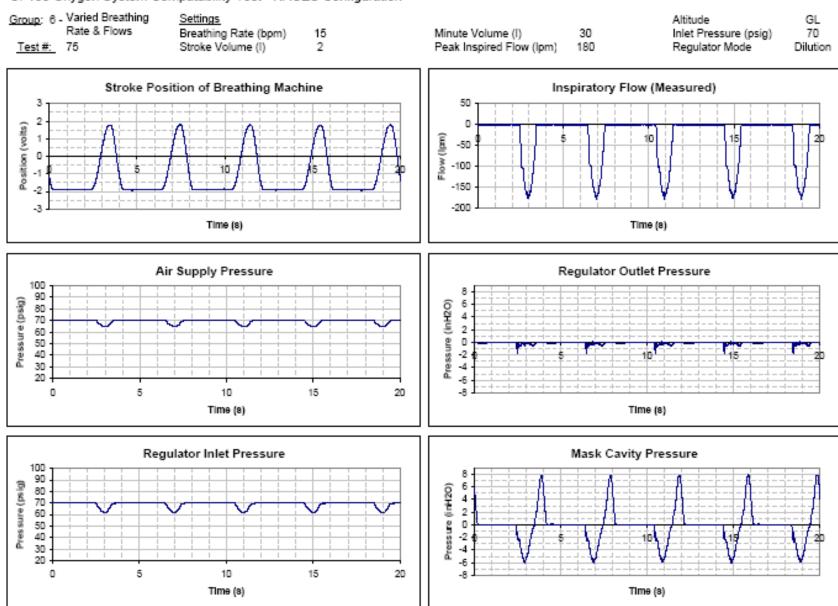
Group: 5 - Multi Extremes Test #: 70	Settings Breathing Rate (bpm) Stroke Volume (I)	22 1.82	Minute Volume (I) Peak Inspired Flow (Ipm)	40 160	Altitude Inlet Pressure (psig) Regulator Mode	45 40 100%
Stroke Position of Breathing Machine 3 2 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			Inspiratory Flow (Measured) 50 0 -50 -100 -150 -200 Time (8)			
100 90 90 80 70 90 90 90 90 90 90 90 90 90 90 90 90 90	Air Supply Pressure 10 Time (8)	15 20	Bressure (0740) 8 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	egulator Outlet I	15	20
Re 100 90 90 70 60 70 60 30 20 0 5	gulator Inlet Pressure	15 20	0 12 0 0 5	Mask Cavity Pro	15	20

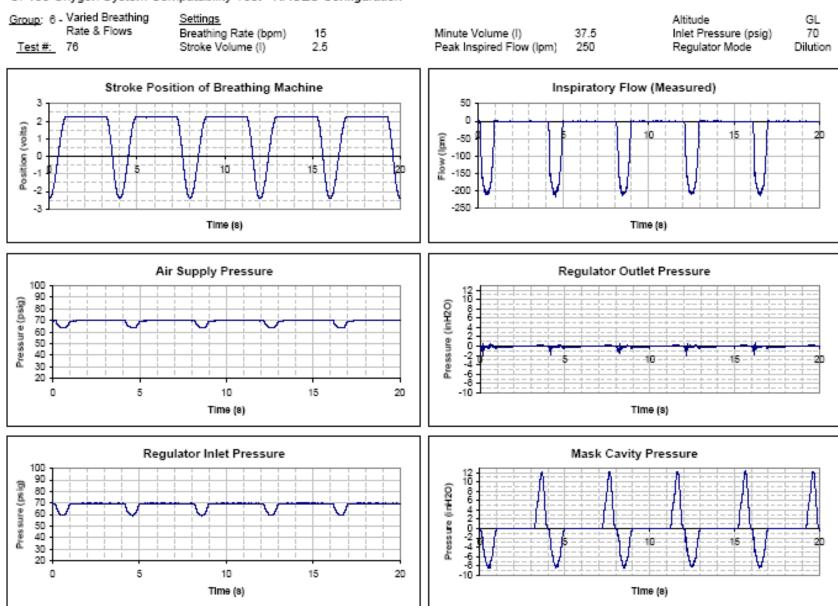


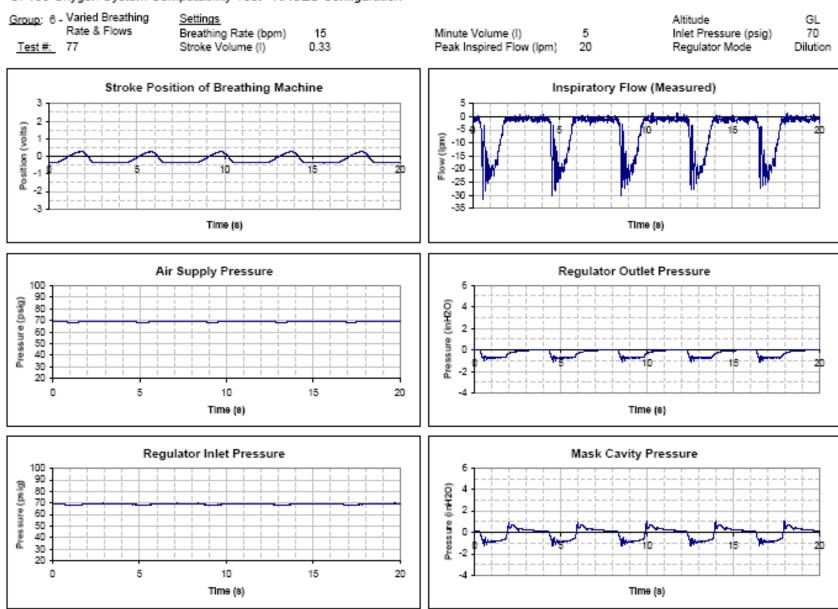


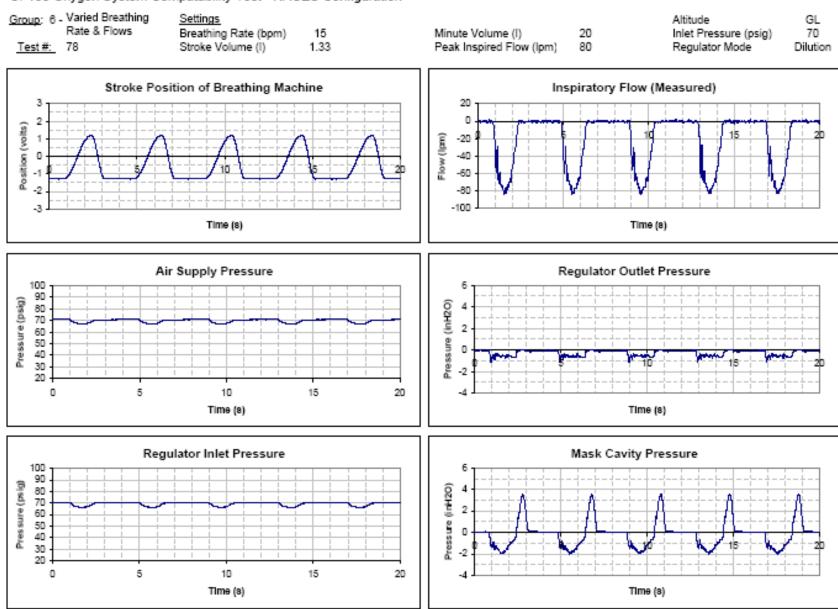












CF188 Oxygen System Compatability Test - NACES Configuration

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Time (8)

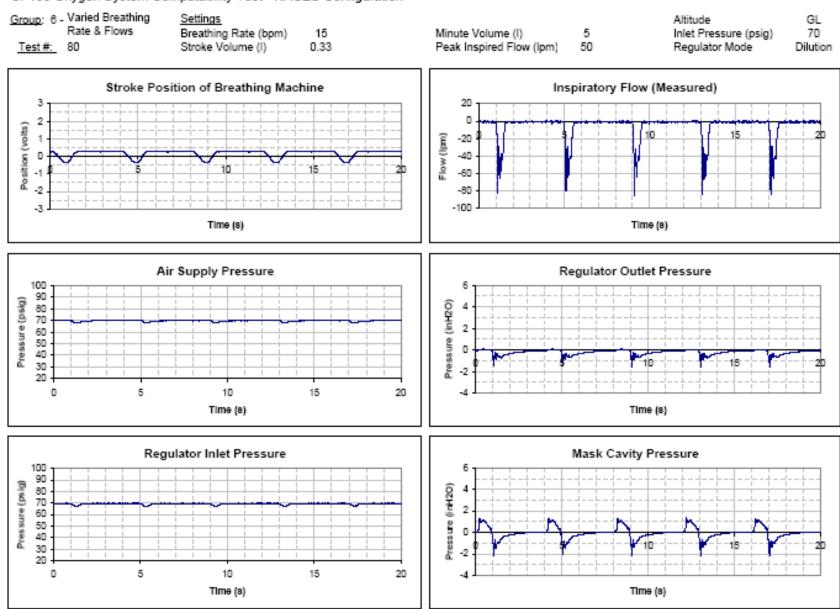
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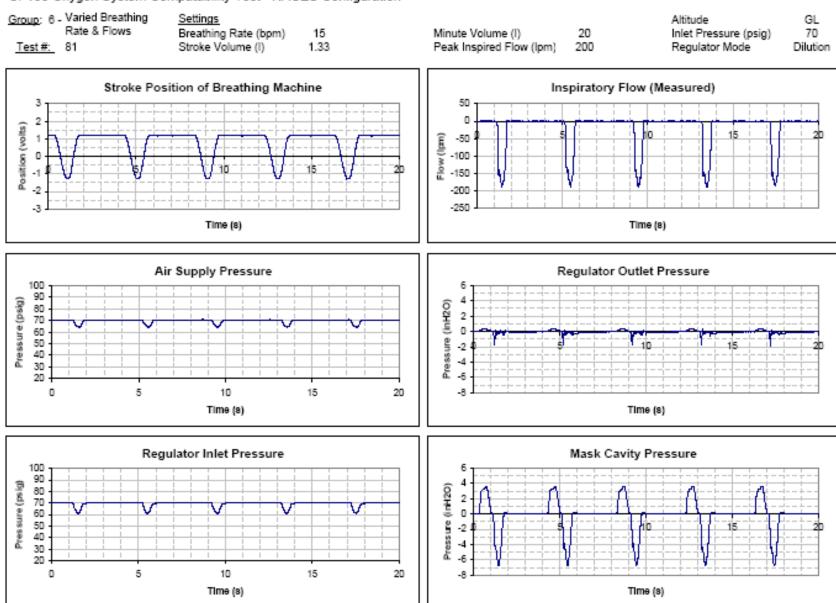
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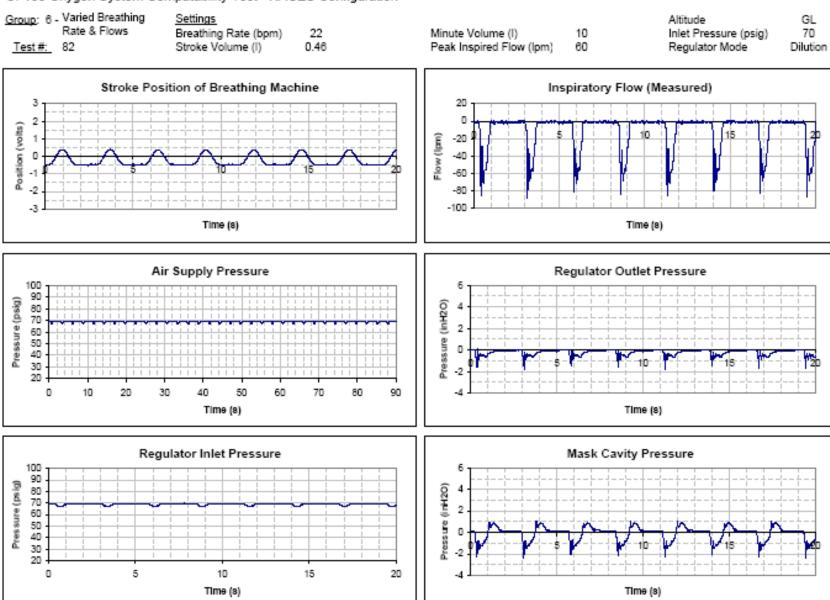
Group: 6 - Varied Breathing Settings Rate & Flows Breathing Rate (bpm) 15 Test #: 79 Stroke Volume (I) 2.5	Minute Volume (I) 37.5 Inlet Pressure (psig) 70 Peak Inspired Flow (Ipm) 150 Regulator Mode Dilution			
Stroke Position of Breathing Machine	Inspiratory Flow (Measured)			
(strong) 1 1 15 120 15 16 17 16 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18	(i) No -100 -200 Time (a)			
Air Supply Pressure 100 90 80 70 50 40 30 20 0 5 10 15 20 Time (a)	Regulator Outlet Pressure 12			
Regulator Inlet Pressure	Mask Cavity Pressure			

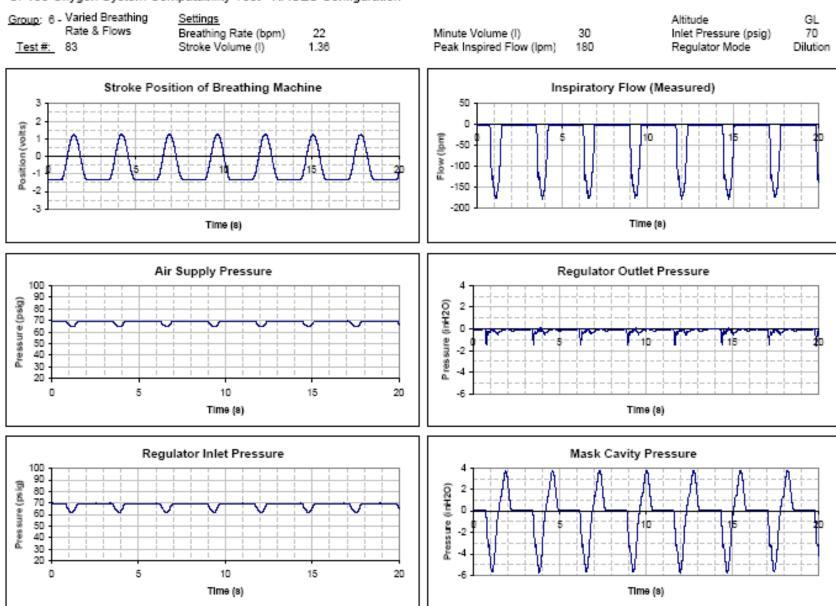
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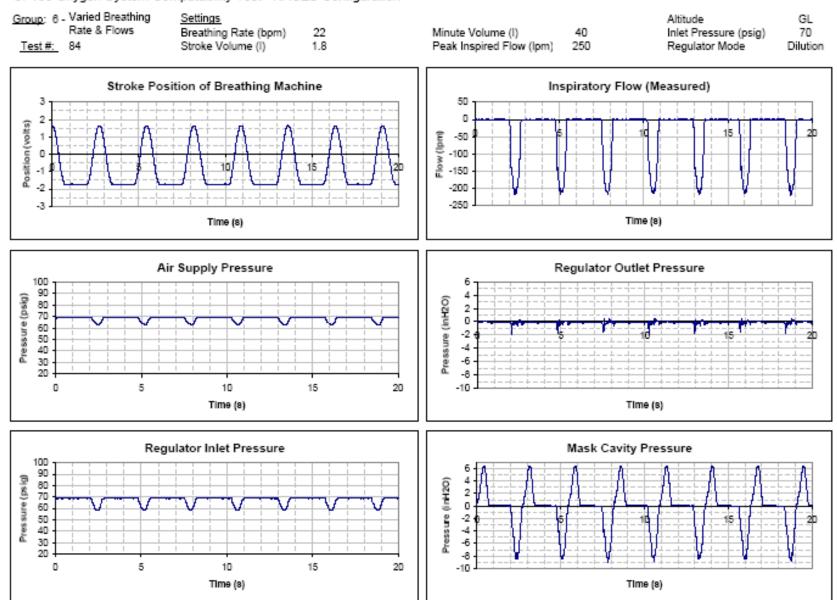
Time (8)











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- (U) A series of 84 unmanned tests of the NACES-configuration CF188 oxygen system were conducted to demonstrate compatibility of system components reflected by acceptable flow and pressure characteristics. Results confirmed acceptable system performance in each regulator mode and over the operating ranges of inlet pressure, altitude and breathing profile, varied both individually and in combination.
- (U) French abstract not available.
- 14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)
- (U) aircraft, oxygen system, test, compatibility

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